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Groundwater Remedial Investigation Report

Volume 2: Figures

Reynolds Metals Company
TROUTDALE FACILITY

CH2MHILL

June 1999

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Volume 2
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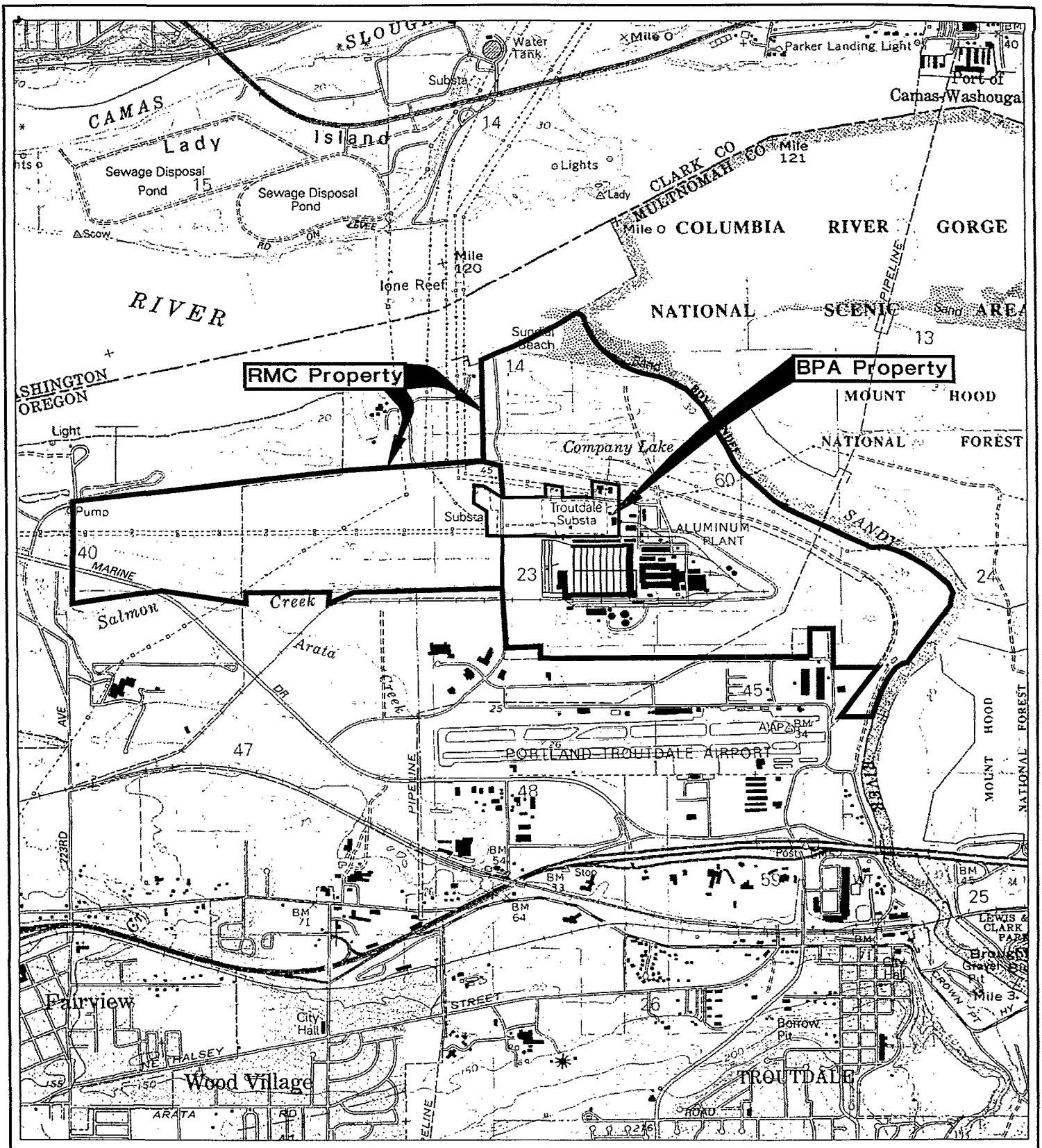
SECTION 1

Introduction



0 1000 2000
SCALE IN FEET

N

LEGEND

APPROXIMATE RMC PROPERTY BOUNDARY

Figure 1-1
VICINITY MAP
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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17-MAY-1999

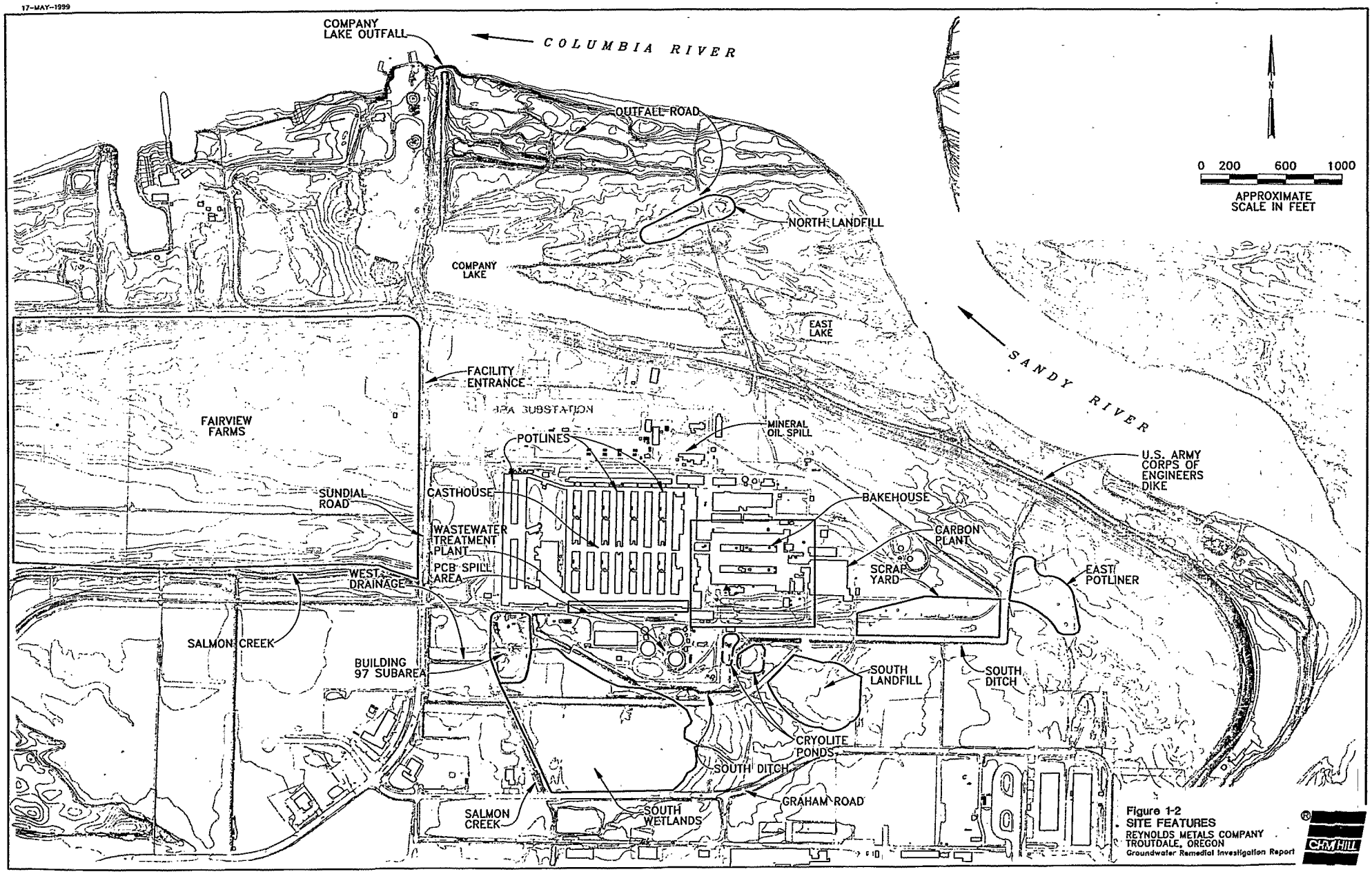

Figure 1-2
SITE FEATURES
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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SECTION 2

Groundwater Remedial Investigation and Evaluation

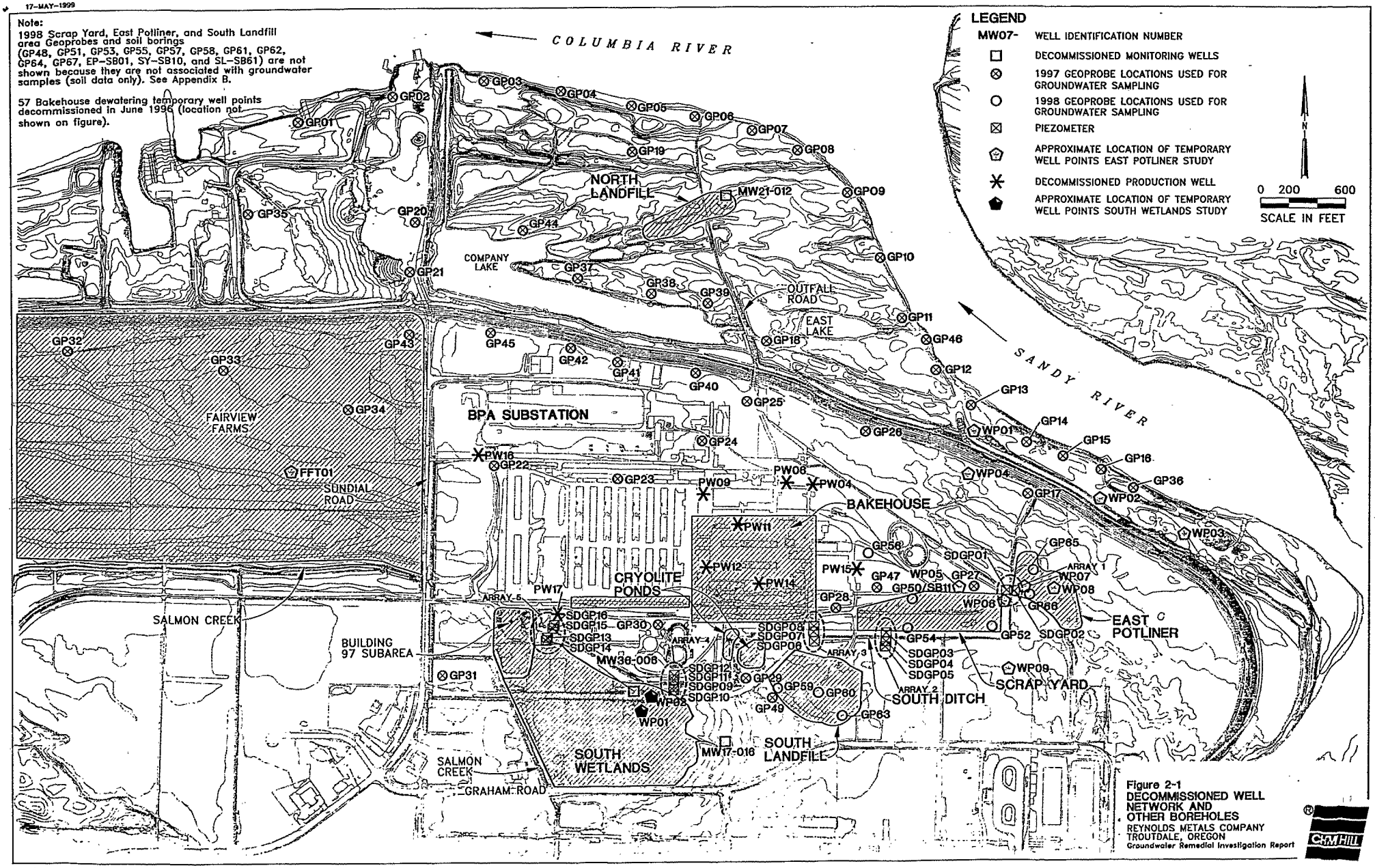

Figure 2-1
DECOMMISSIONED WELL NETWORK AND OTHER BOREHOLES
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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COLOR7.DWG

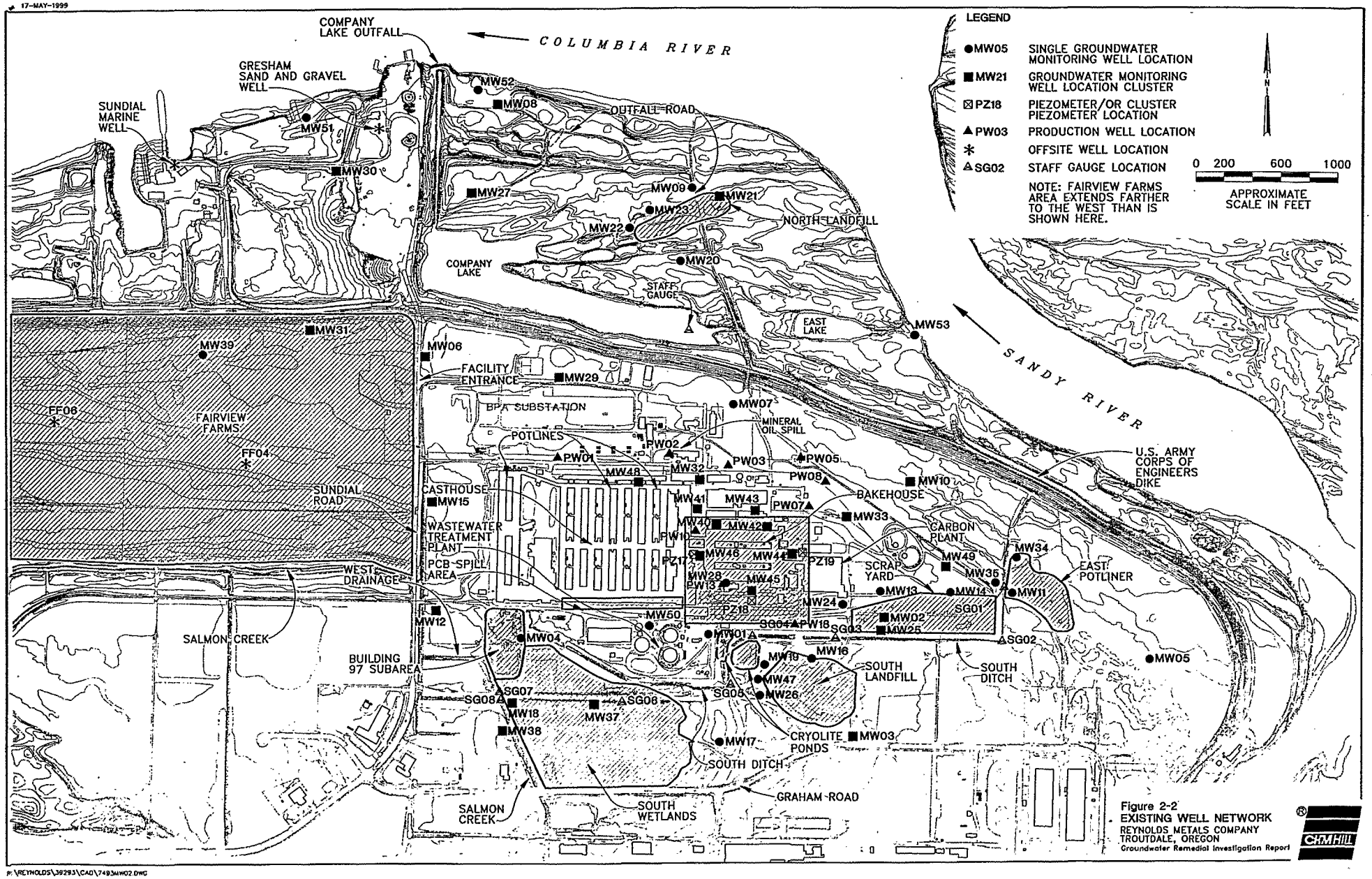

Figure 2-2
EXISTING WELL NETWORK
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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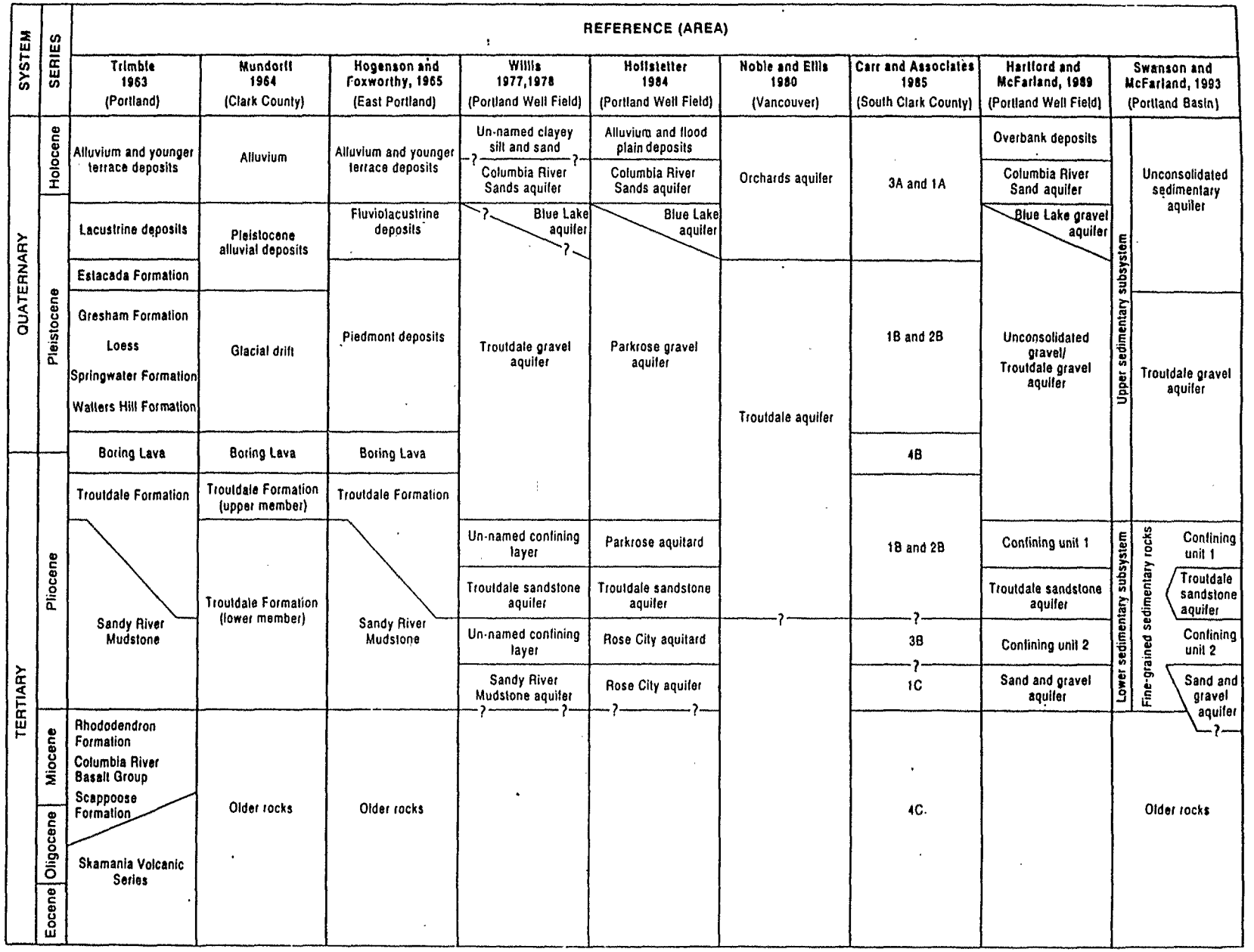
SECTION 3

Conceptual Hydrogeologic Model



Source: Swanson, R.D., and W.D. McFarland. 1993.

FIGURE 3-1

Comparison of Hydrogeologic Unit Terminology for the Portland Basin

REYNOLDS METALS COMPANY
TROUTDALE, OREGON

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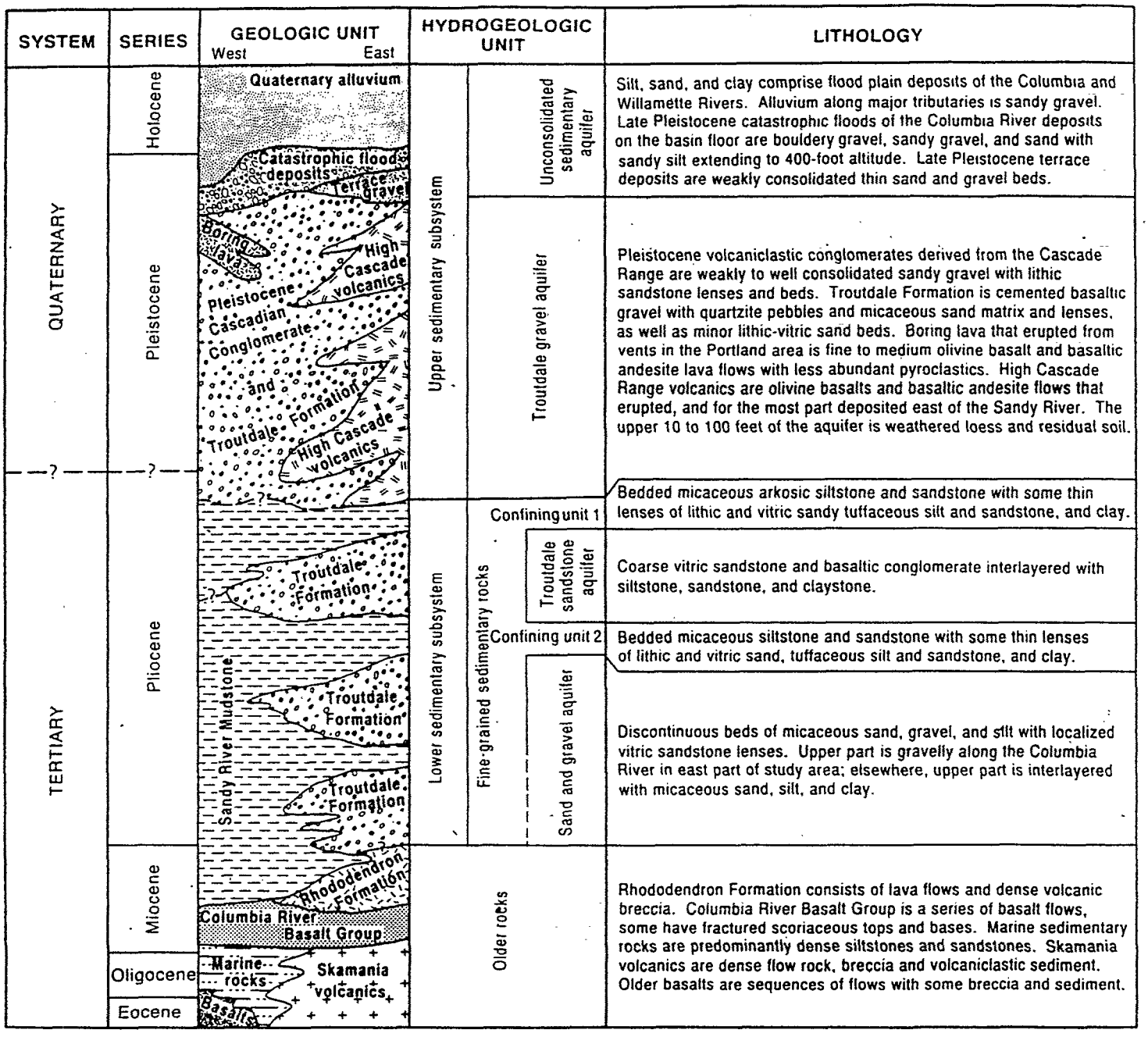

Source: Swanson et al., 1993.

FIGURE 3-2

Summary of Hydrogeologic Units

REYNOLDS METALS COMPANY
TROUTDALE, OREGON

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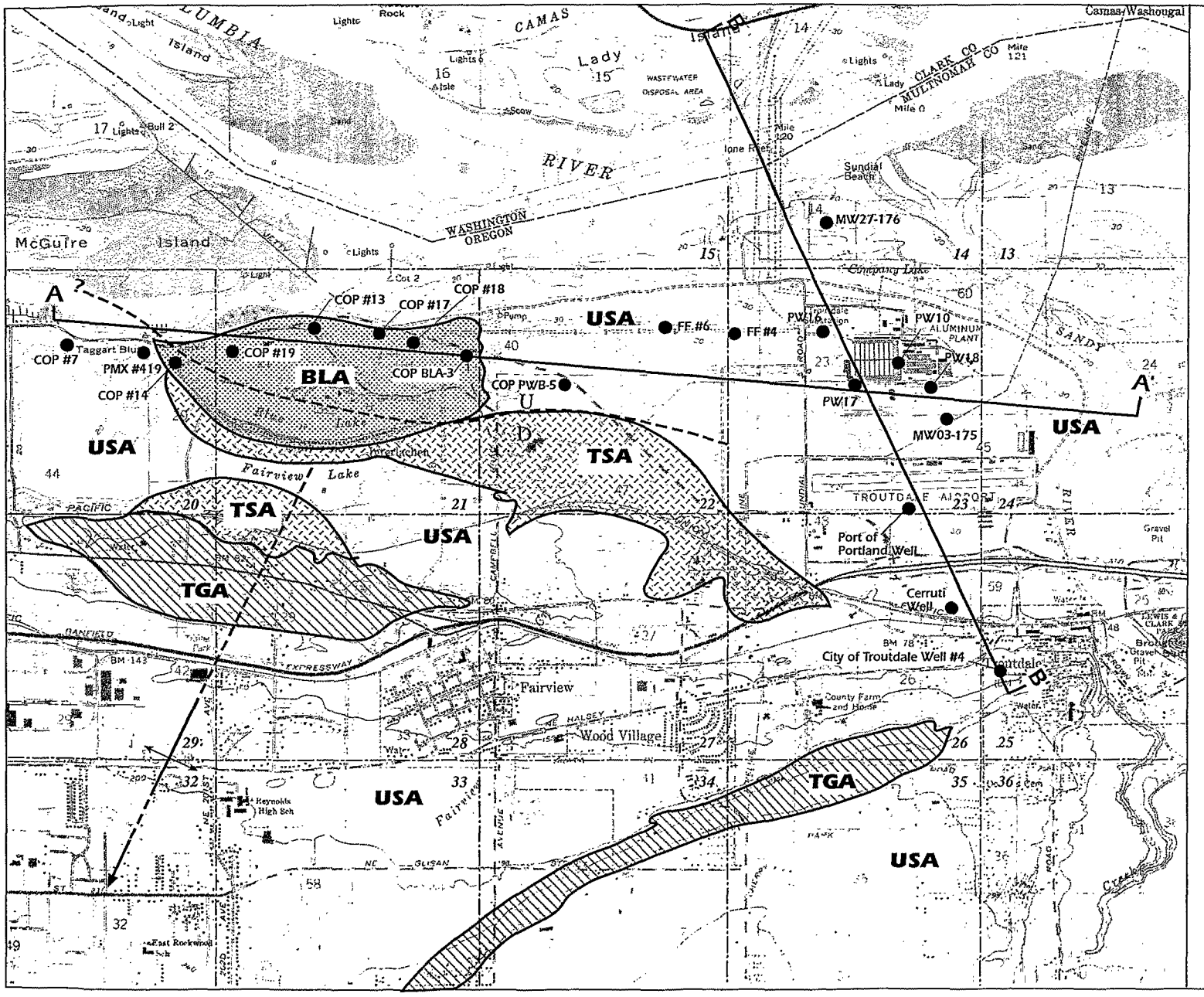

LEGEND

- FF #6 — Selected well location used to develop cross section (location to nearest 1/4-1/4 section)
- A — A' — Cross section location

Hydrogeologic Unit Boundary

- USA — Unconsolidated Sedimentary Aquifer
- BLA — Blue Lake Aquifer/Gravel
- TGA — Troutdale Gravel Aquifer
- TSA — Troutdale Sandstone Aquifer

- Approximate contact of hydrogeologic units
- U / D — Approximate fault location U = upthrown / D = downthrown
- Plunging anticline, line dashed where inferred

- PW — Reynolds Metals Company production well
- PMX — Parametrix (1991)
- COP — City of Portland test well
- PWB — Portland Water Bureau
- FF — Fairview Farms, owned by RMC

Hydrogeologic Unit Boundary by Swanson (1993).

Structural features and extent of the Blue Lake Gravel/Aquifer by Bet and Rosner (1993). The Blue Lake Gravel/Aquifer is not present at ground surface.

Base map: U.S. Geological Survey 7.5 minute Camas, Washington quadrangle. Photo revised 1970 and 1975. Contour interval: 10 feet.

Horizontal scale: 1 inch = 2,000 feet
Vertical scale: 1 inch = 100 feet
Vertical exaggeration: 20x

NORTH

Figure 3-3
HYDROGEOLOGIC MAP AND CROSS SECTION A-A' AND B-B' LOCATIONS
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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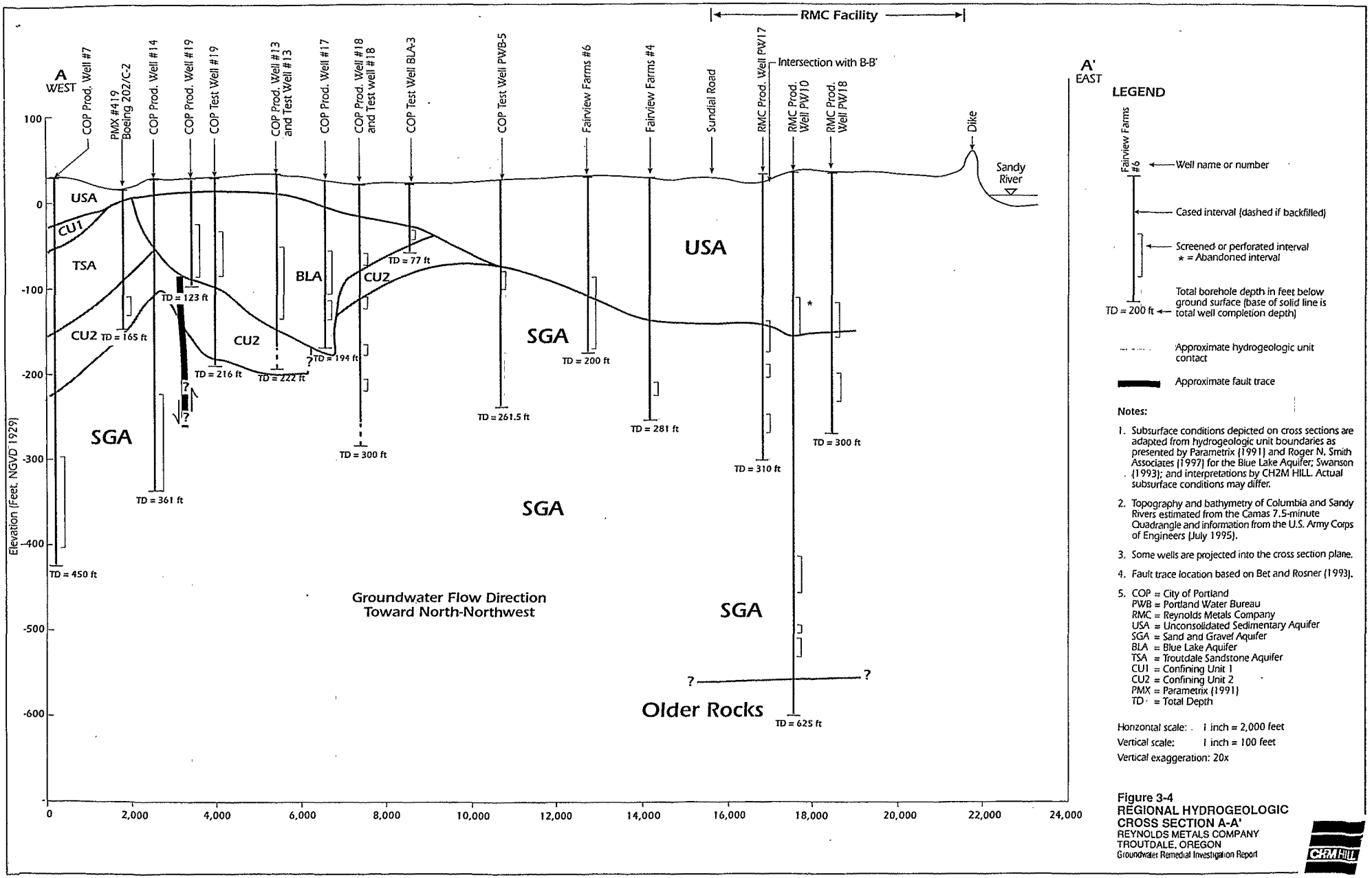

Notes:

1. Subsurface conditions depicted on cross sections are adapted from hydrogeologic unit boundaries as presented by Parametrix (1991) and Roger N. Smith Associates (1997) for the Blue Lake Aquifer; Swanson (1993); and interpretations by CH2M HILL. Actual subsurface conditions may differ.
2. Topography and bathymetry of Columbia and Sandy Rivers estimated from the Camas 7.5-minute Quadrangle and information from the U.S. Army Corps of Engineers (July 1995).
3. Some wells are projected into the cross section plane.
4. Fault trace location based on Bet and Rosner (1993).
5. COP = City of Portland
   PWB = Portland Water Bureau
   RMC = Reynolds Metals Company
   USA = Unconsolidated Sedimentary Aquifer
   SGA = Sand and Gravel Aquifer
   BLA = Blue Lake Aquifer
   TSA = Troutdale Sandstone Aquifer
   CU1 = Confining Unit 1
   CU2 = Confining Unit 2
   PMX = Parametrix (1991)
   TD = Total Depth

Horizontal scale: 1 inch = 2,000 feet
Vertical scale: 1 inch = 100 feet
Vertical exaggeration: 20x

Figure 3-4
REGIONAL HYDROGEOLOGIC CROSS SECTION A-A'
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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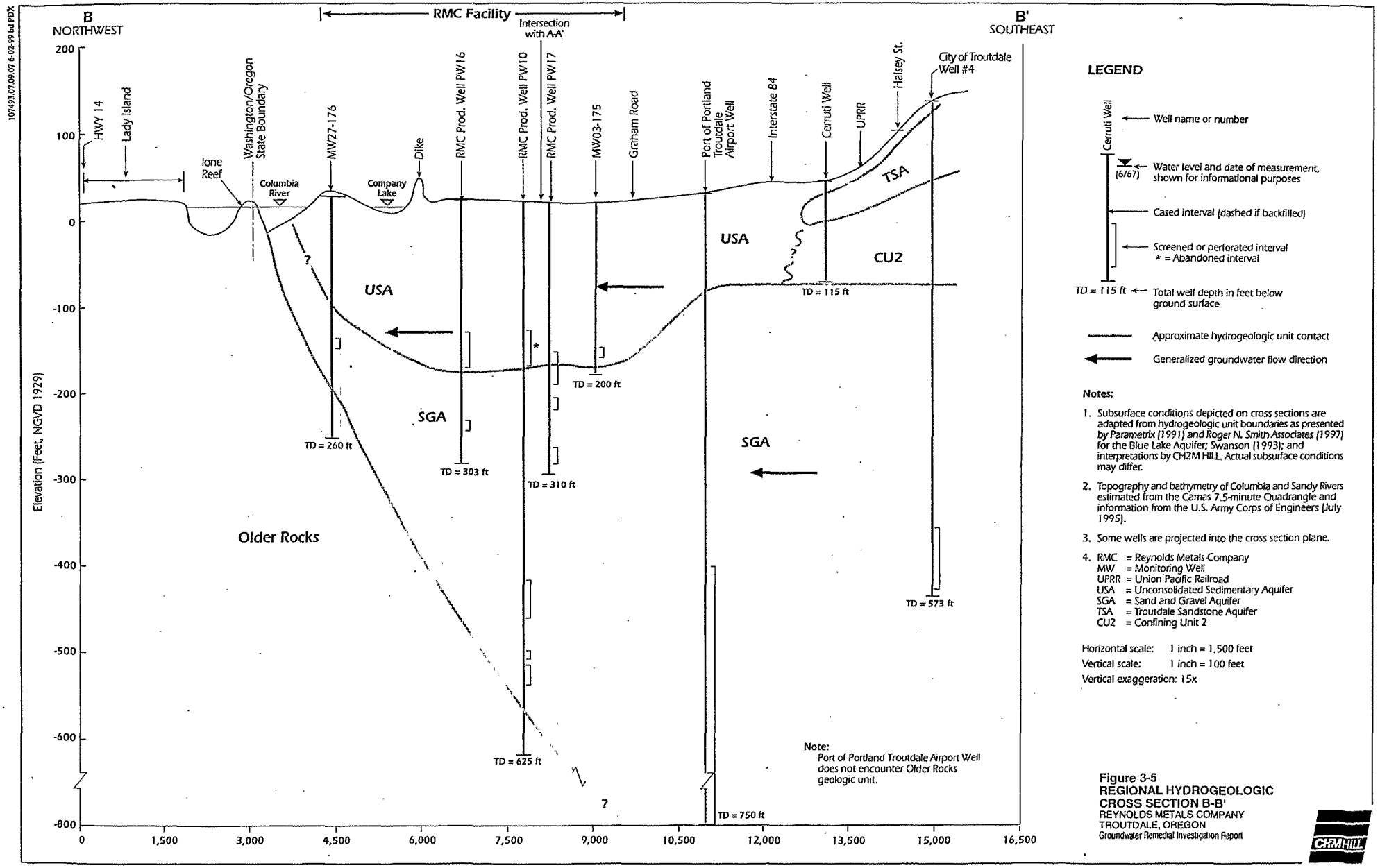

Notes:

1. Subsurface conditions depicted on cross sections are adapted from hydrogeologic unit boundaries as presented by Parametrix (1991) and Roger N. Smith Associates (1997) for the Blue Lake Aquifer; Swanson (1993); and interpretations by CH2M HILL. Actual subsurface conditions may differ.
2. Topography and bathymetry of Columbia and Sandy Rivers estimated from the Camas 7.5-minute Quadrangle and information from the U.S. Army Corps of Engineers (July 1995).
3. Some wells are projected into the cross section plane.
4. RMC = Reynolds Metals Company
   MW = Monitoring Well
   UPRR = Union Pacific Railroad
   USA = Unconsolidated Sedimentary Aquifer
   SGA = Sand and Gravel Aquifer
   TSA = Troutdale Sandstone Aquifer
   CU2 = Confining Unit 2

Horizontal scale: 1 inch = 1,500 feet
Vertical scale: 1 inch = 100 feet
Vertical exaggeration: 15x

Figure 3-5
REGIONAL HYDROGEOLOGIC CROSS SECTION B-B'
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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107493.07.09 07 6-02-99 bd PDX

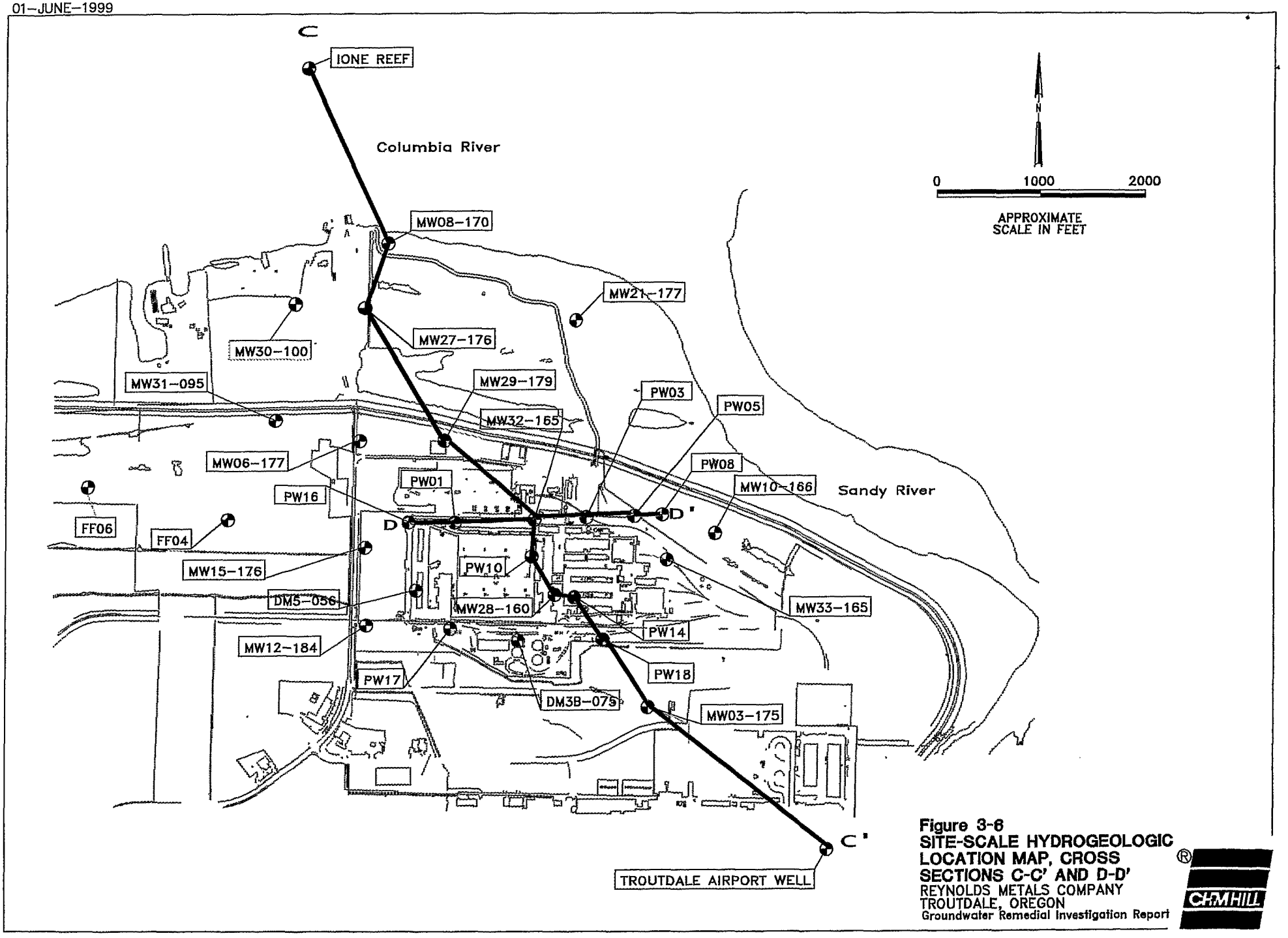

Figure 3-6
SITE-SCALE HYDROGEOLOGIC LOCATION MAP, CROSS SECTIONS C-C' AND D-D'
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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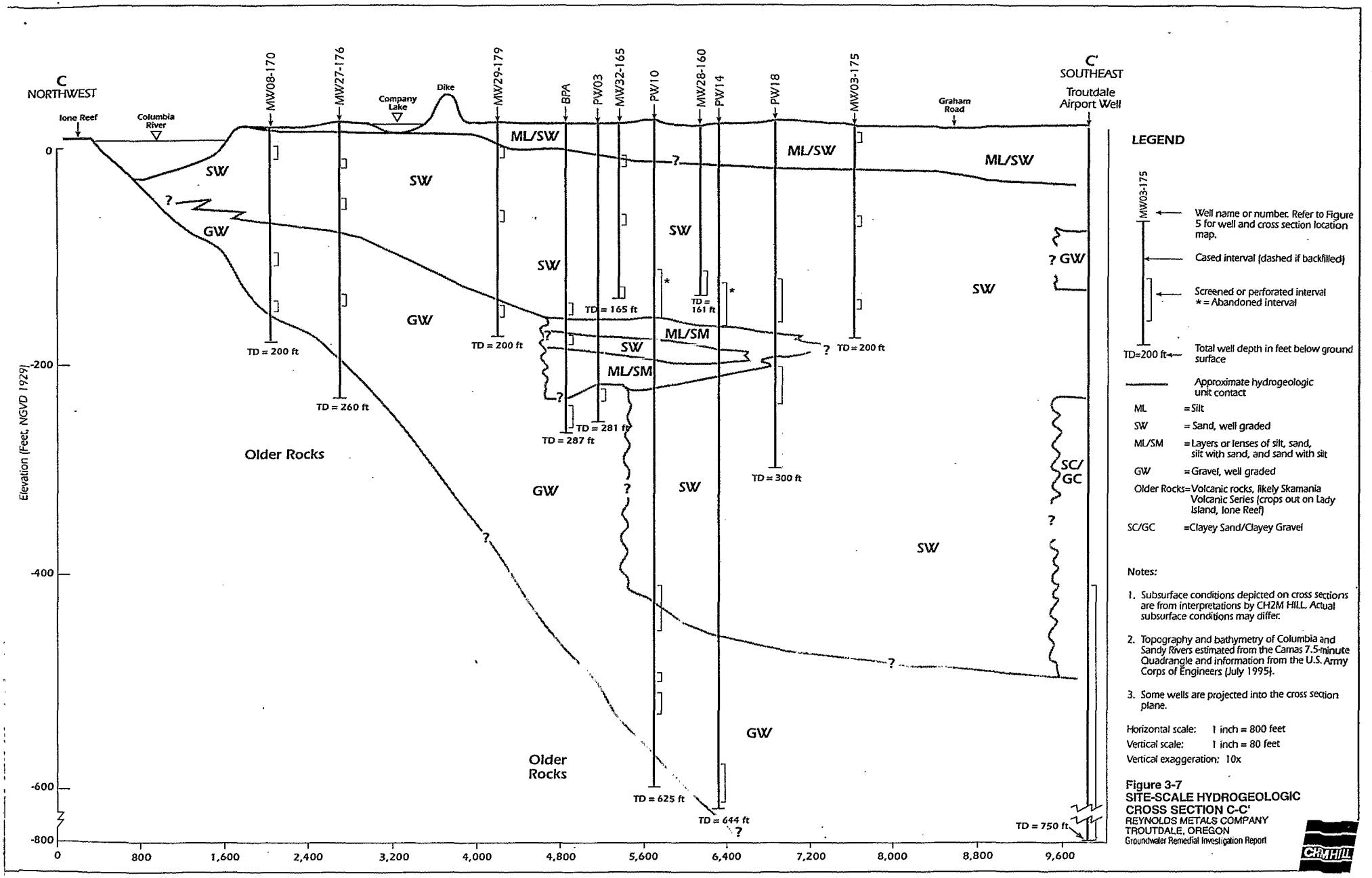
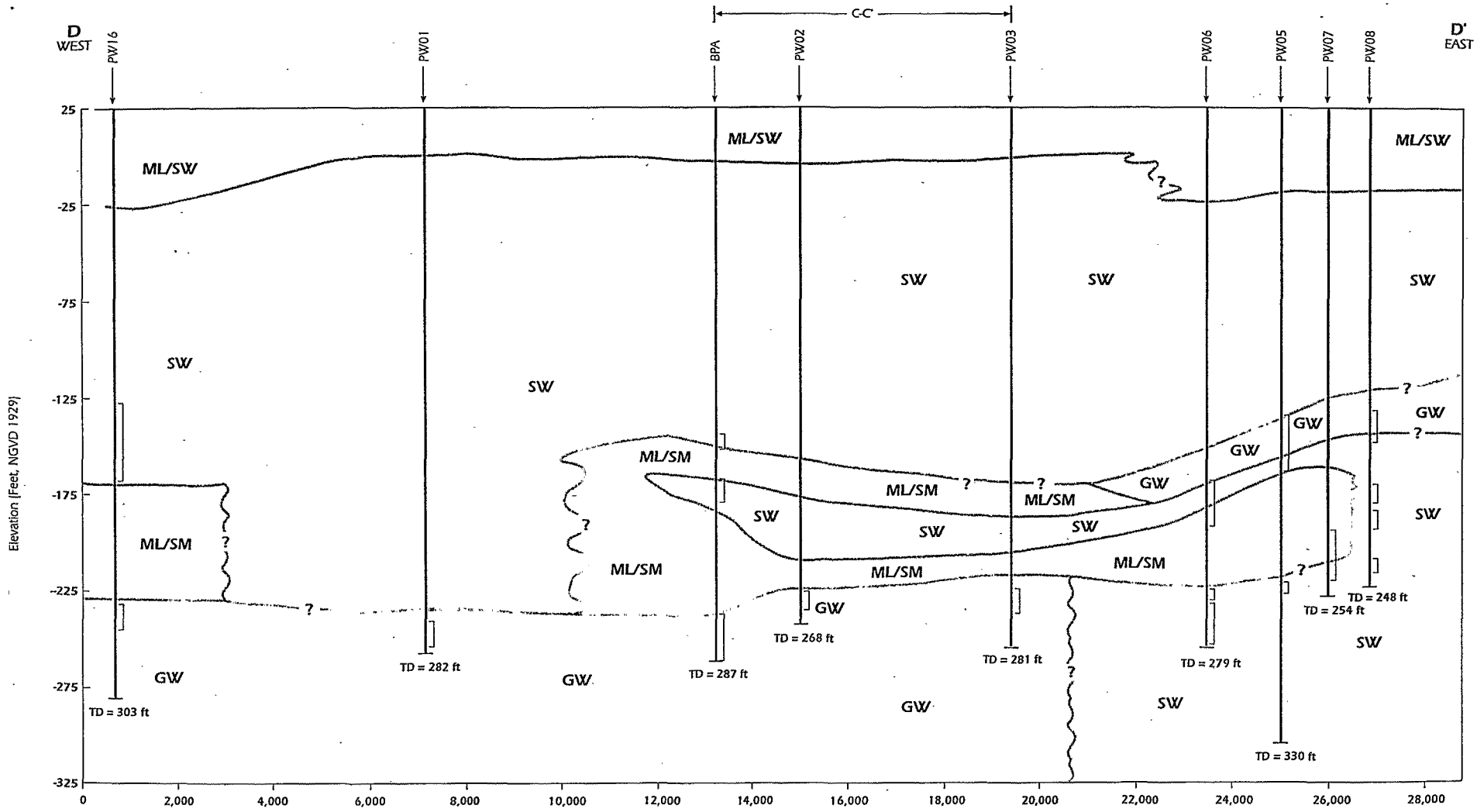


Figure 3-7
SITE-SCALE HYDROGEOLOGIC CROSS SECTION C-C'
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

CH2MHILL



LEGEND

PW16 — Well name or number. Refer to Figure 5 for well and cross section location map.

Cased interval (dashed if backfilled)

Screened or perforated interval

TD = 200 ft — *Total borehole depth in feet below ground surface (base of solid line is total well completion depth)*

Approximate hydrogeologic unit contact

Approximate fault trace

Horizontal scale: 1 inch = 2,000 feet
Vertical scale: 1 inch = 50 feet
Vertical exaggeration: 40x

ML = Silt
SW = Sand, well graded
ML/SM = Layers or lenses of silt, sand, silt with sand, and sand with silt
GW = Gravel, well graded
Older Rocks = Volcanic rocks, likely Skamania Volcanic Series (crops out on Lady Island, Ione Reef)

Notes:

1. Subsurface conditions depicted on cross sections are from interpretations by CH2M HILL. Actual subsurface conditions may differ.
2. Topography and bathymetry of Columbia and Sandy Rivers estimated from the Camas 7.5-minute Quadrangle and information from the U.S. Army Corps of Engineers (July 1995).
3. Some wells are projected into the cross section plane.

Figure 3-8
SITE-SCALE HYDROGEOLOGIC CROSS SECTION D-D'
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

CH2MHILL

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27-APR-1999

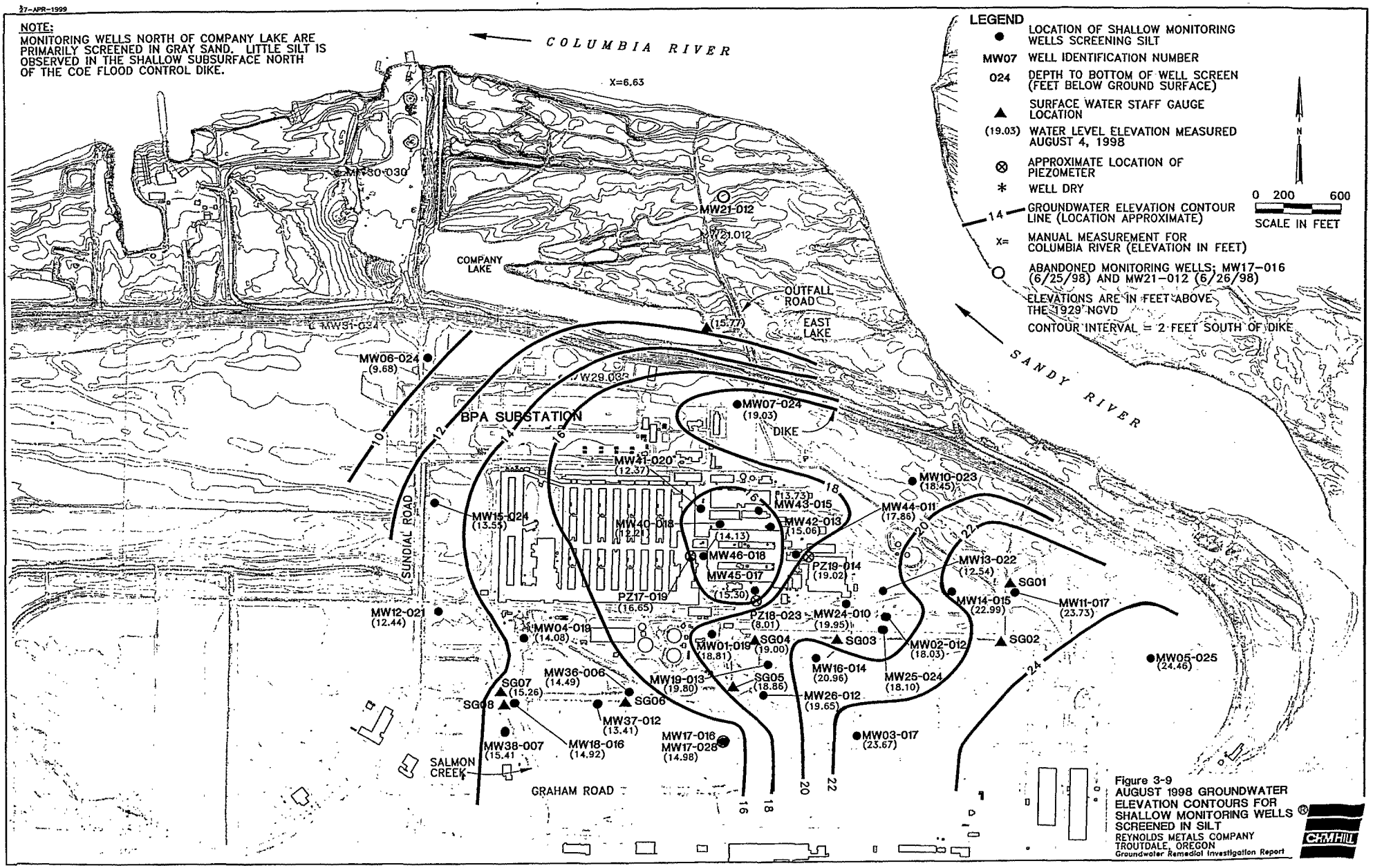

Figure 3-9
AUGUST 1998 GROUNDWATER ELEVATION CONTOURS FOR SHALLOW MONITORING WELLS SCREENED IN SILT
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

CH2MHILL

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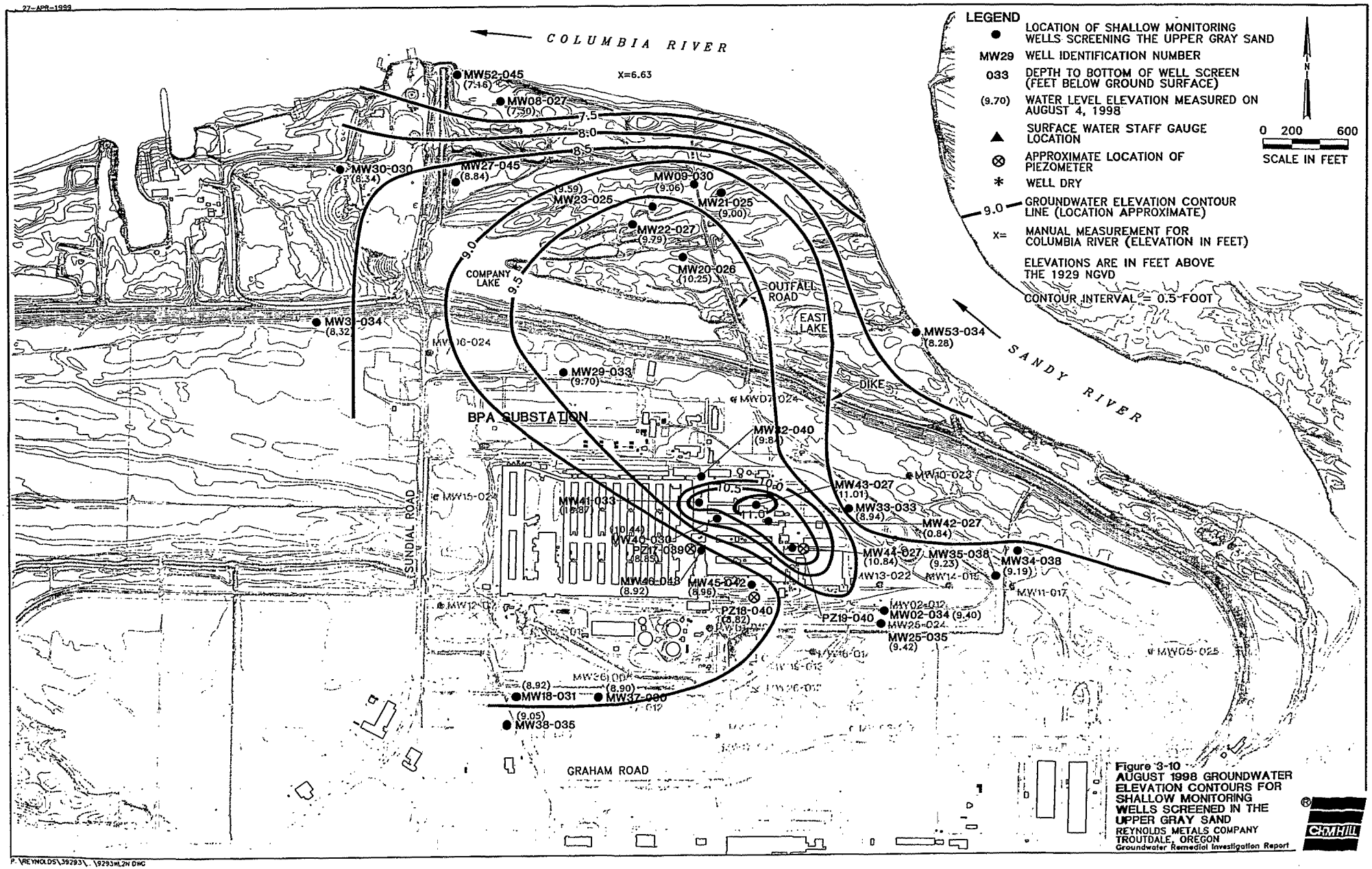

Figure 3-10
AUGUST 1998 GROUNDWATER ELEVATION CONTOURS FOR SHALLOW MONITORING WELLS SCREENED IN THE UPPER GRAY SAND
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

CH2MHILL

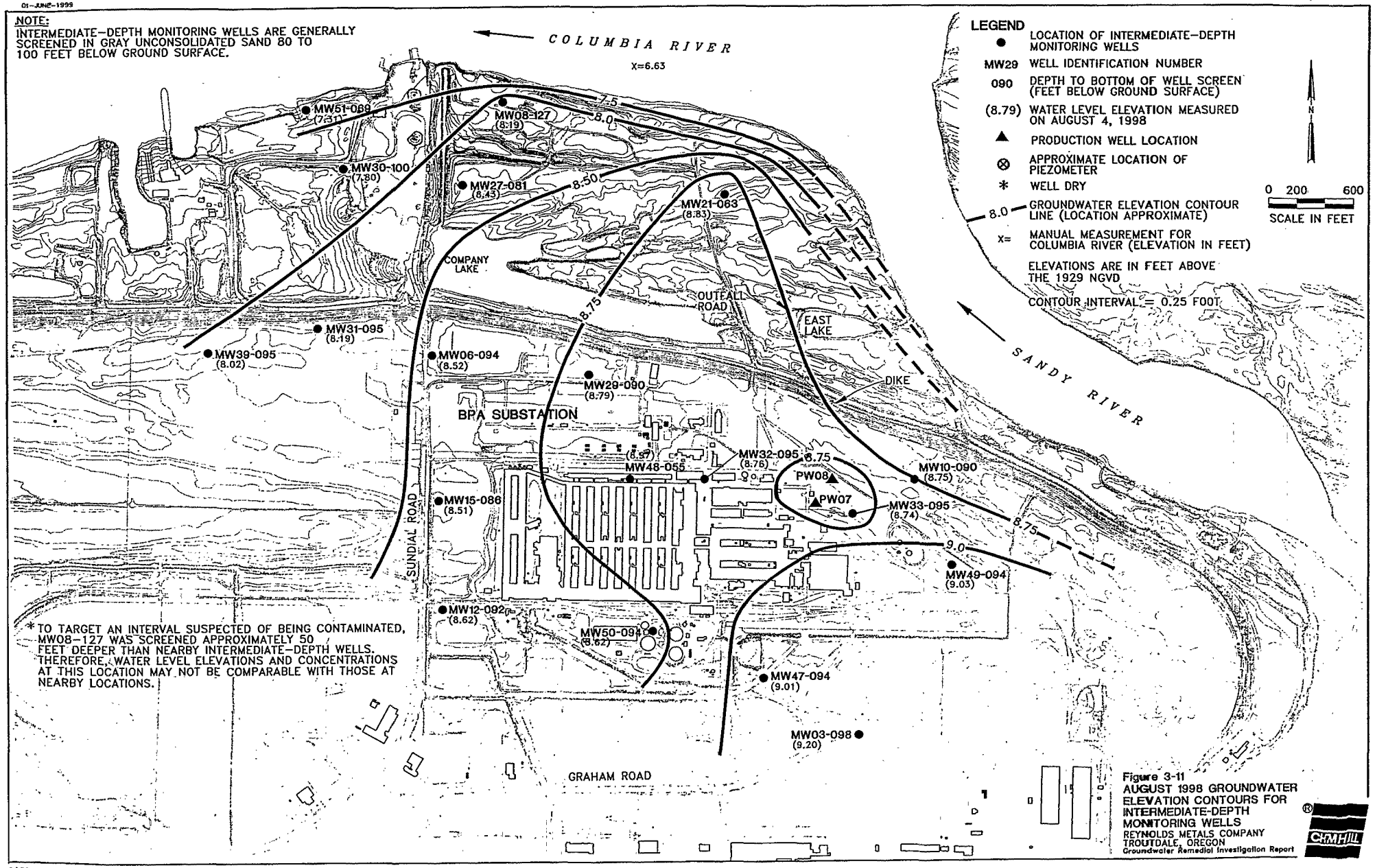

Figure 3-11
AUGUST 1998 GROUNDWATER ELEVATION CONTOURS FOR INTERMEDIATE-DEPTH MONITORING WELLS
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

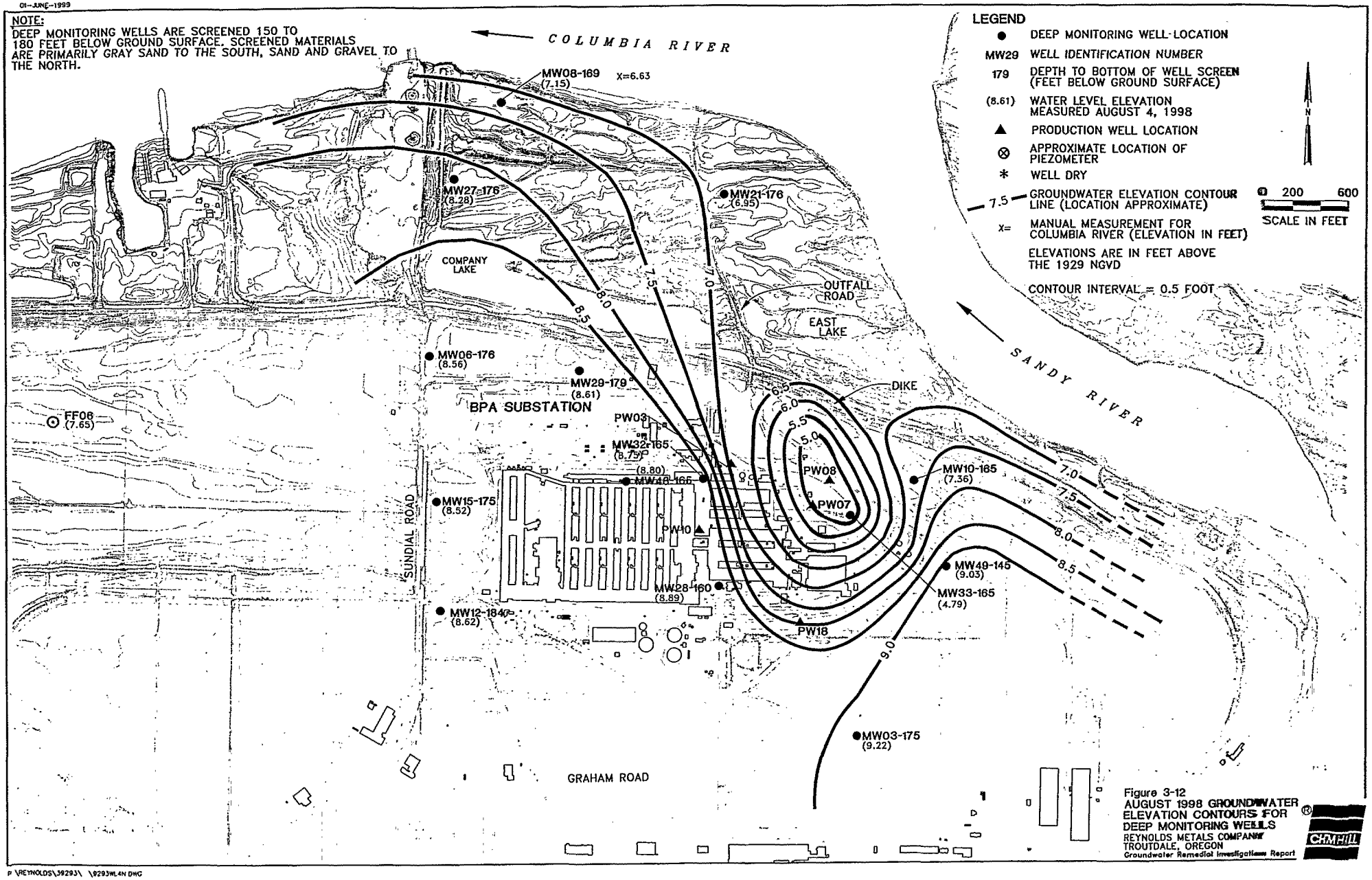

Figure 3-12
AUGUST 1998 GROUNDWATER ELEVATION CONTOURS FOR DEEP MONITORING WELLS
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigations Report

CH2MHILL

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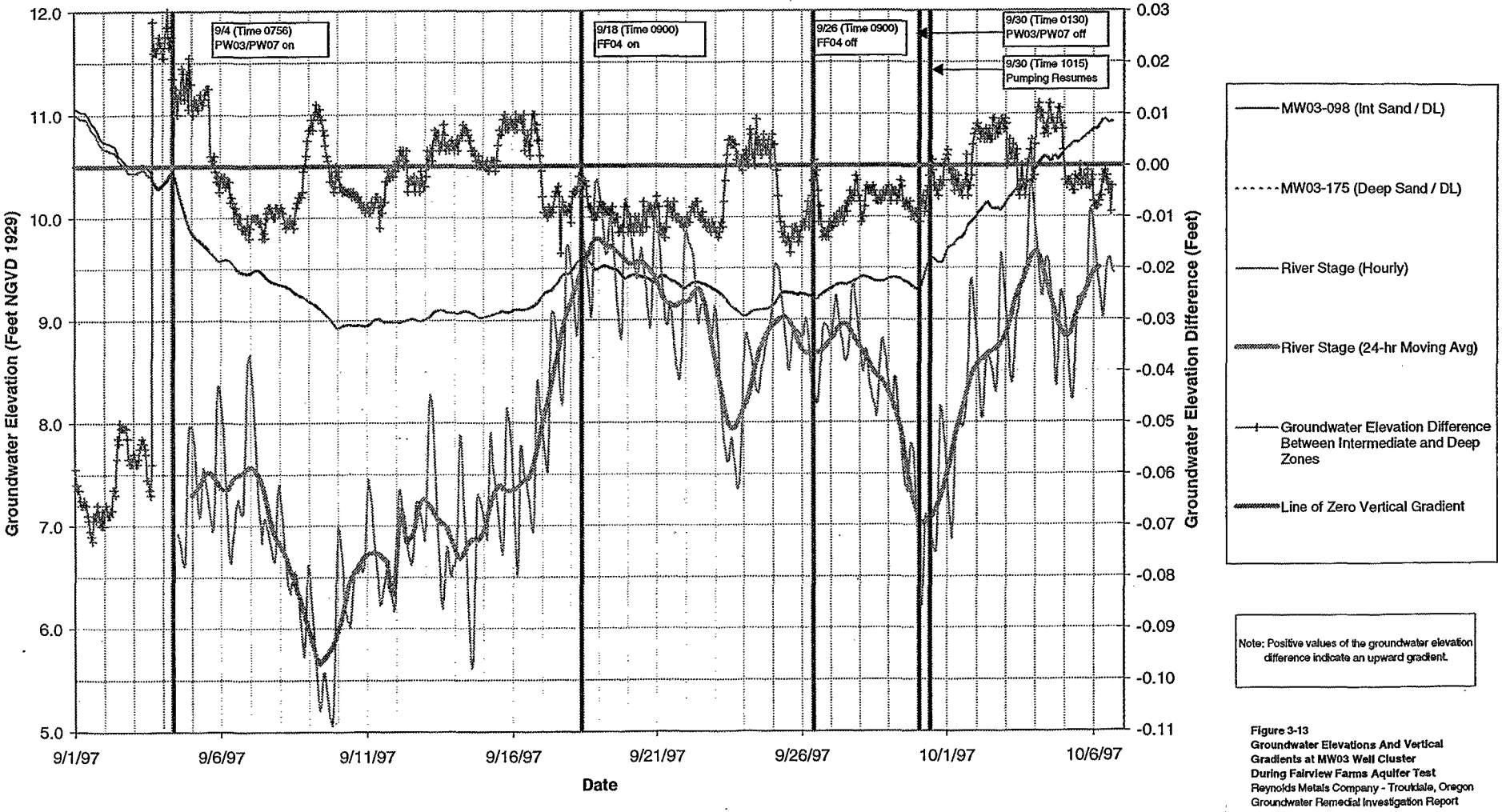
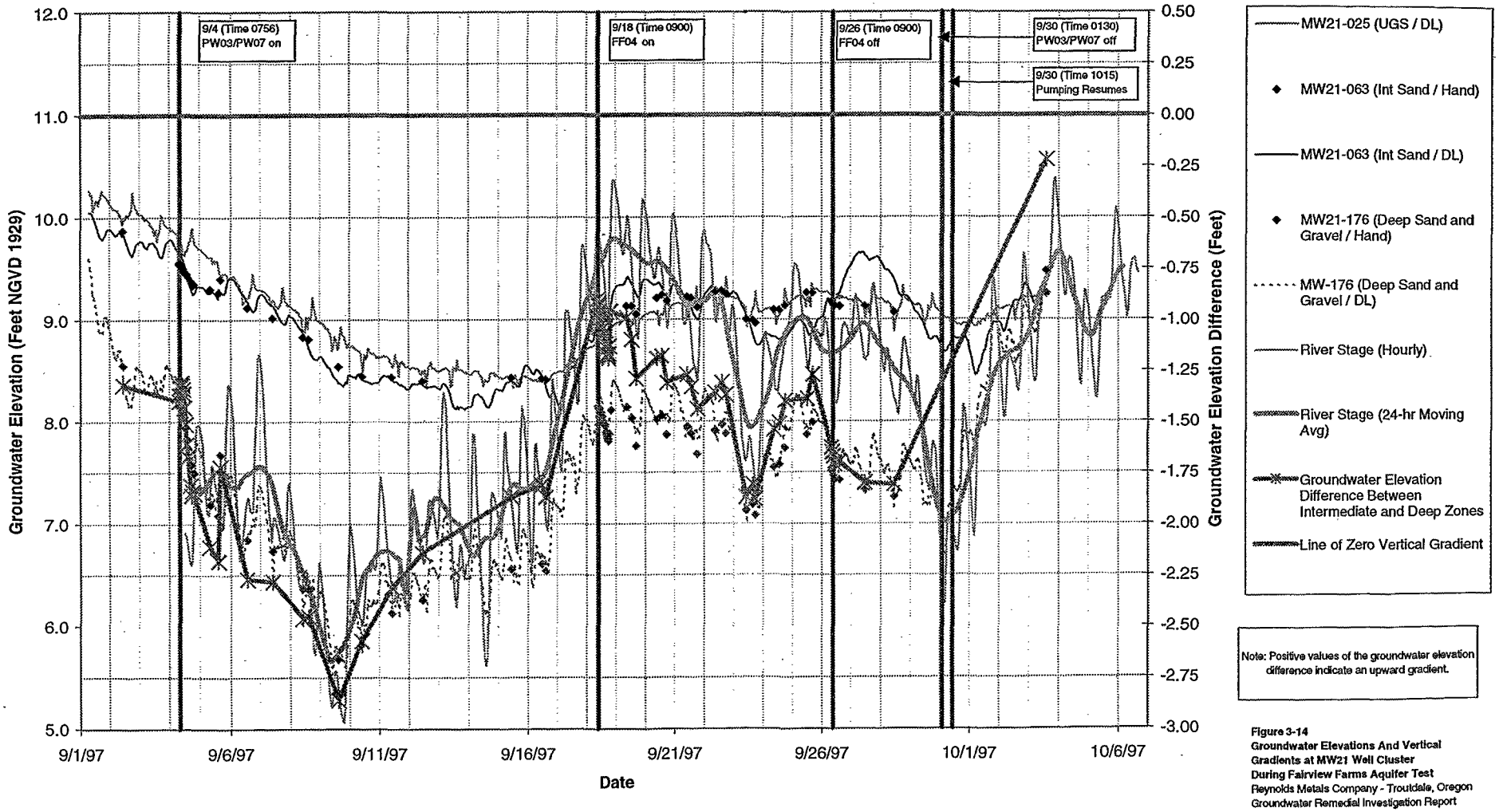


Note: Positive values of the groundwater elevation difference indicate an upward gradient.

Figure 3-13
Groundwater Elevations And Vertical Gradients at MW03 Well Cluster During Fairview Farms Aquifer Test
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report



Note: Positive values of the groundwater elevation difference indicate an upward gradient.

Figure 3-14
Groundwater Elevations And Vertical Gradients at MW21 Well Cluster During Fairview Farms Aquifer Test
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

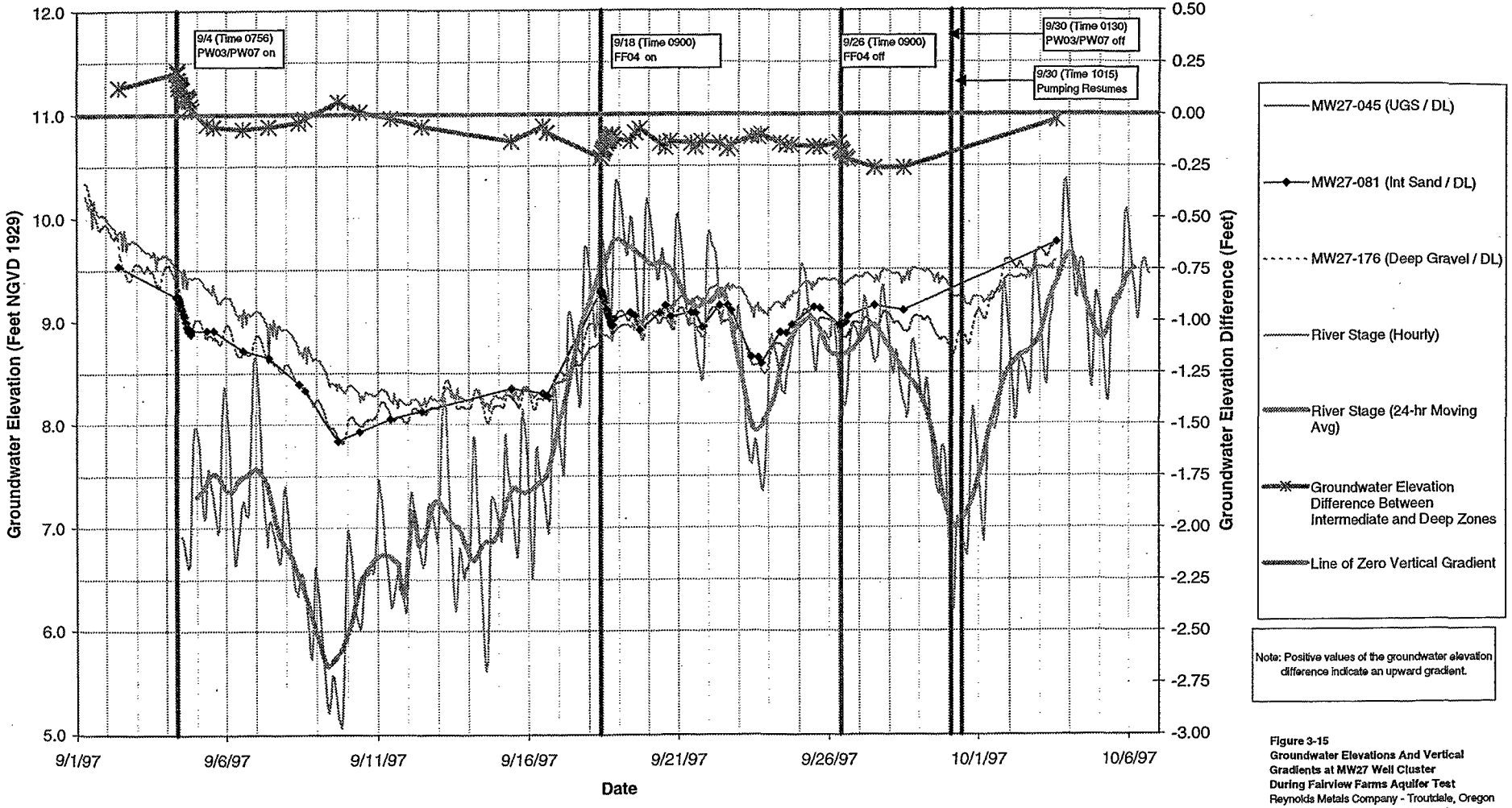


Figure 3-15
Groundwater Elevations And Vertical Gradients at MW27 Well Cluster During Fairview Farms Aquifer Test
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

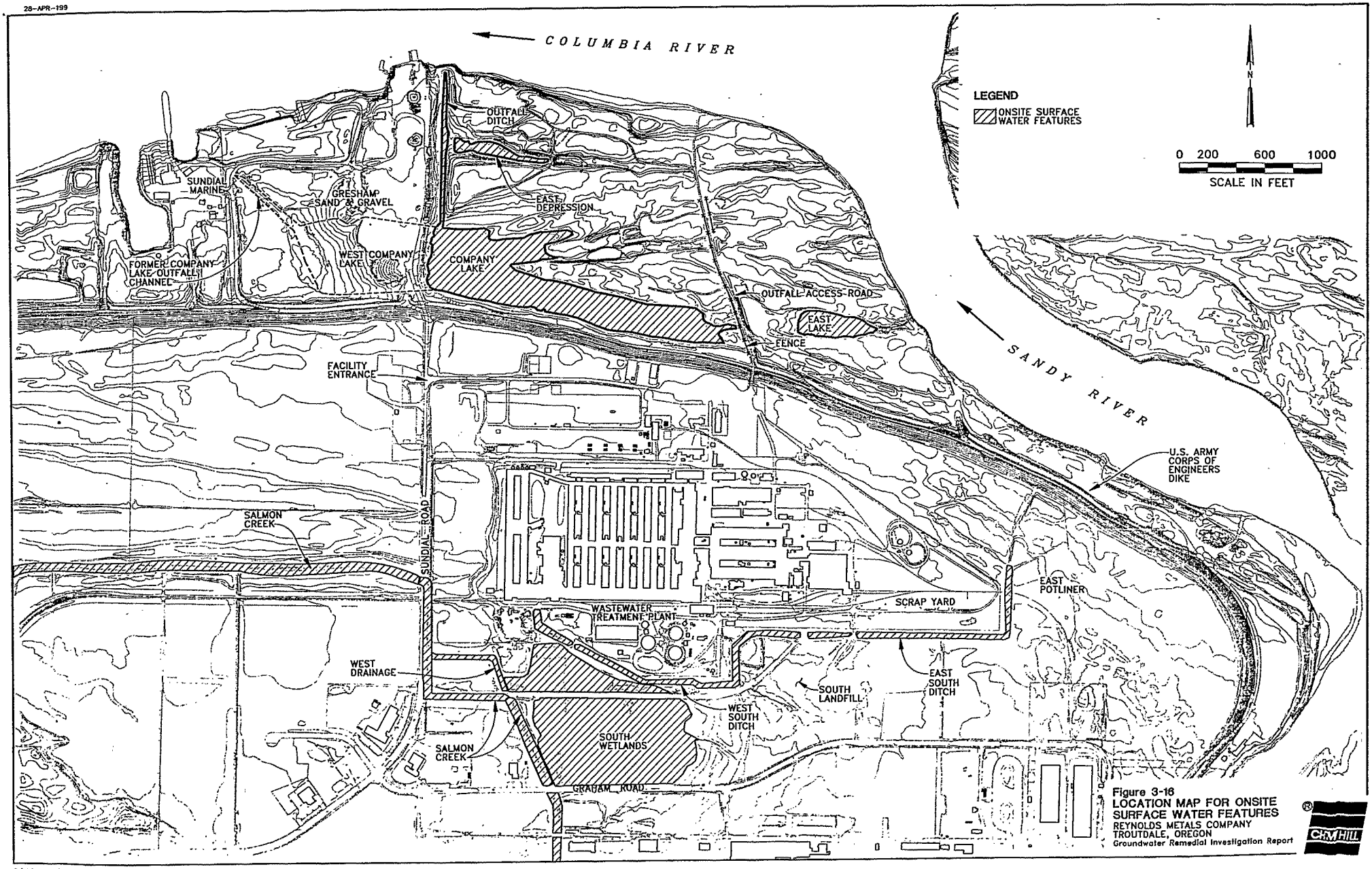


Figure 3-16
LOCATION MAP FOR ONSITE SURFACE WATER FEATURES
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

CH2M HILL

ALR 9293SEC2
28-APR-1999

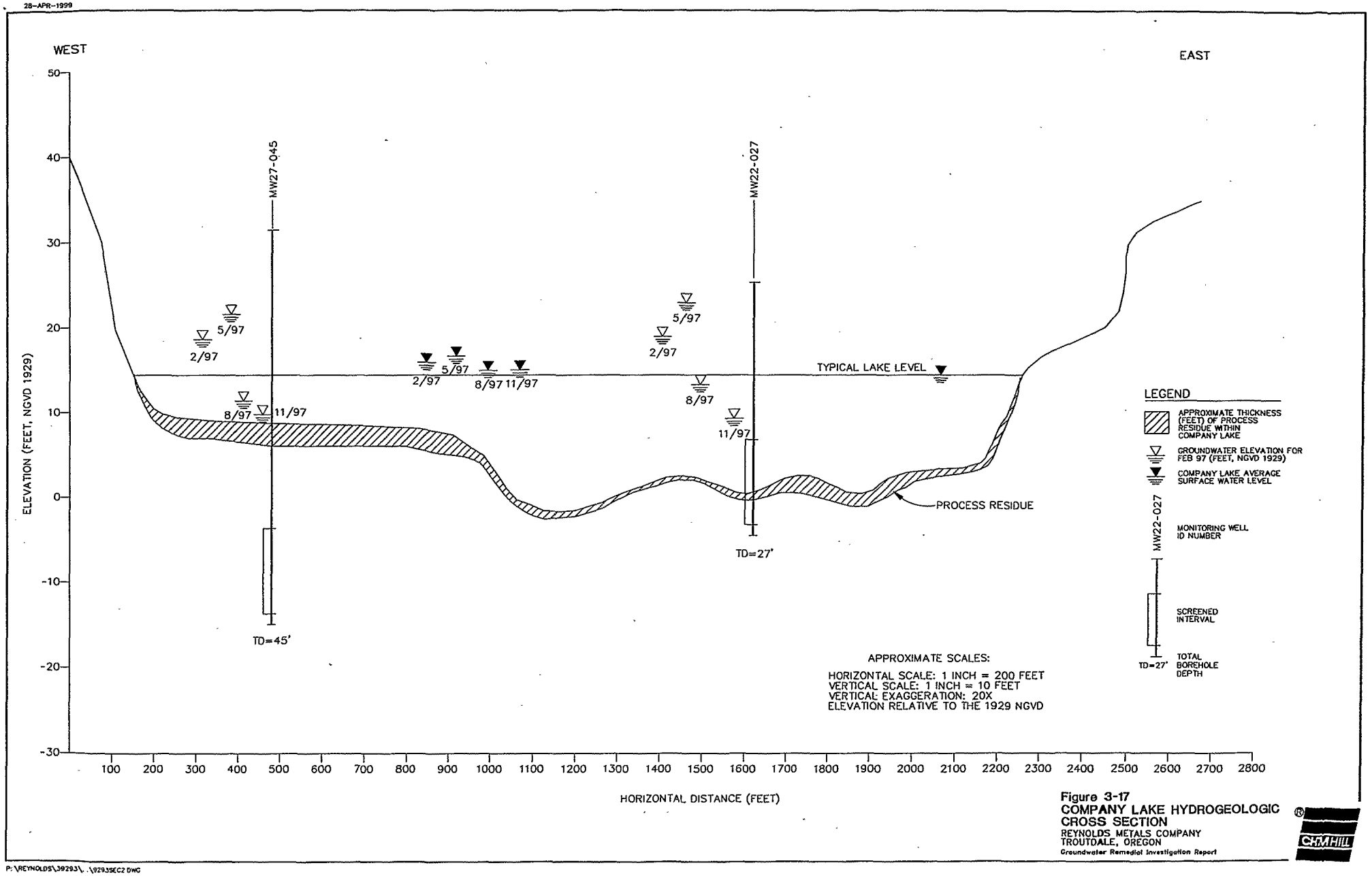


Figure 3-17
COMPANY LAKE HYDROGEOLOGIC CROSS SECTION
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

CH2MHILL

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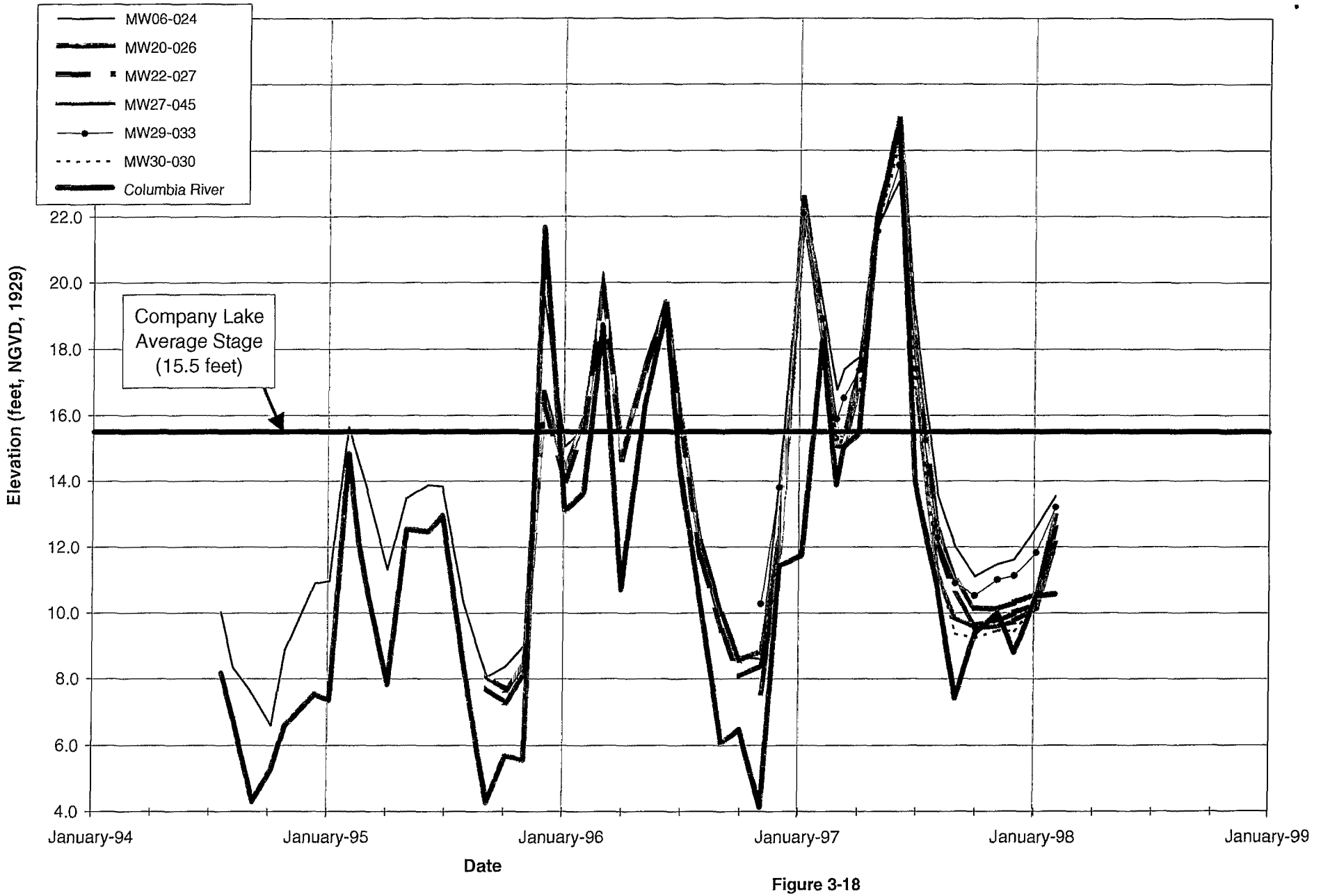


Figure 3-18

Company Lake Stage And UGS Groundwater Elevations

Reynolds Metals Company (Troutdale, Oregon)
Groundwater Remedial Investigation Report

K:\39293\grnd\watlev\COLAKE\colakeugsri.XLS\(UGS) Chart 1994_1997
Printed 5/10/99

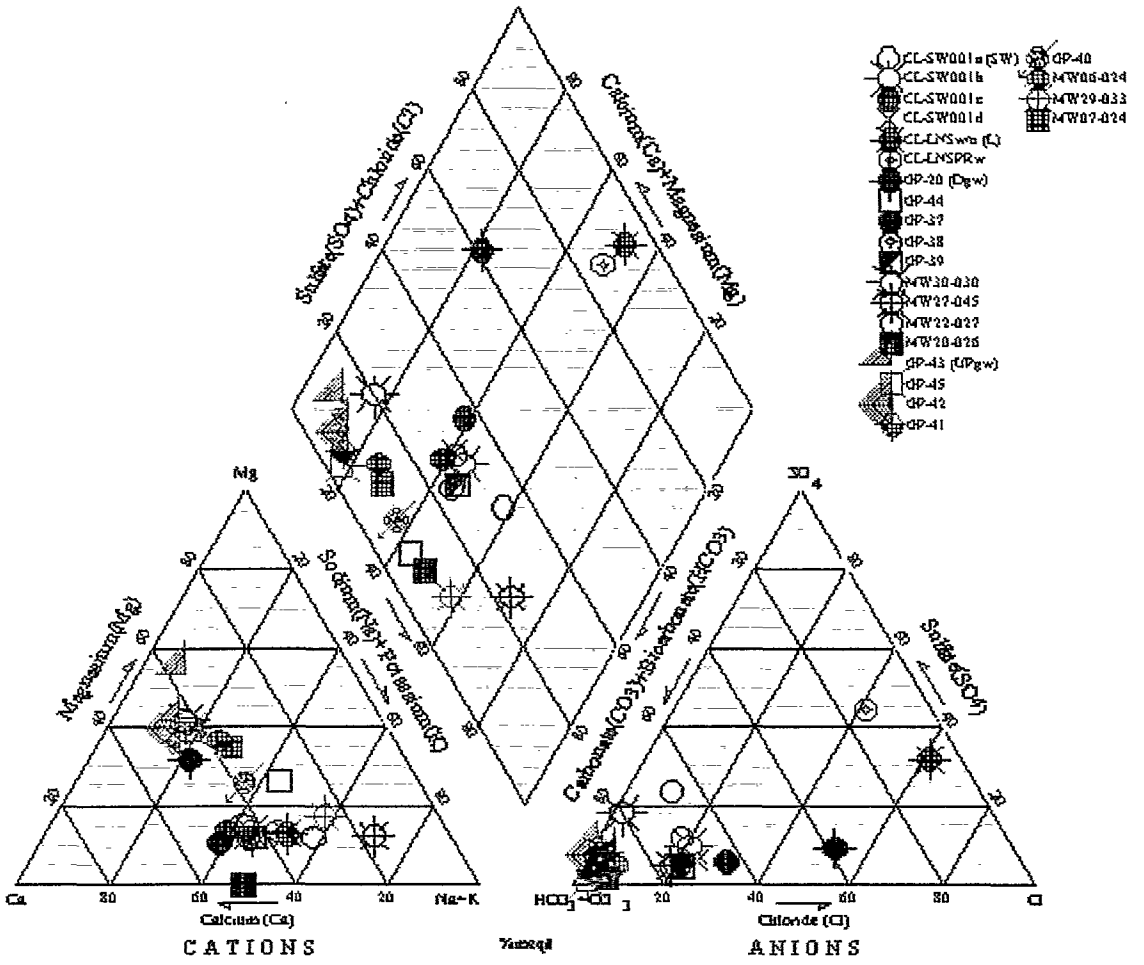
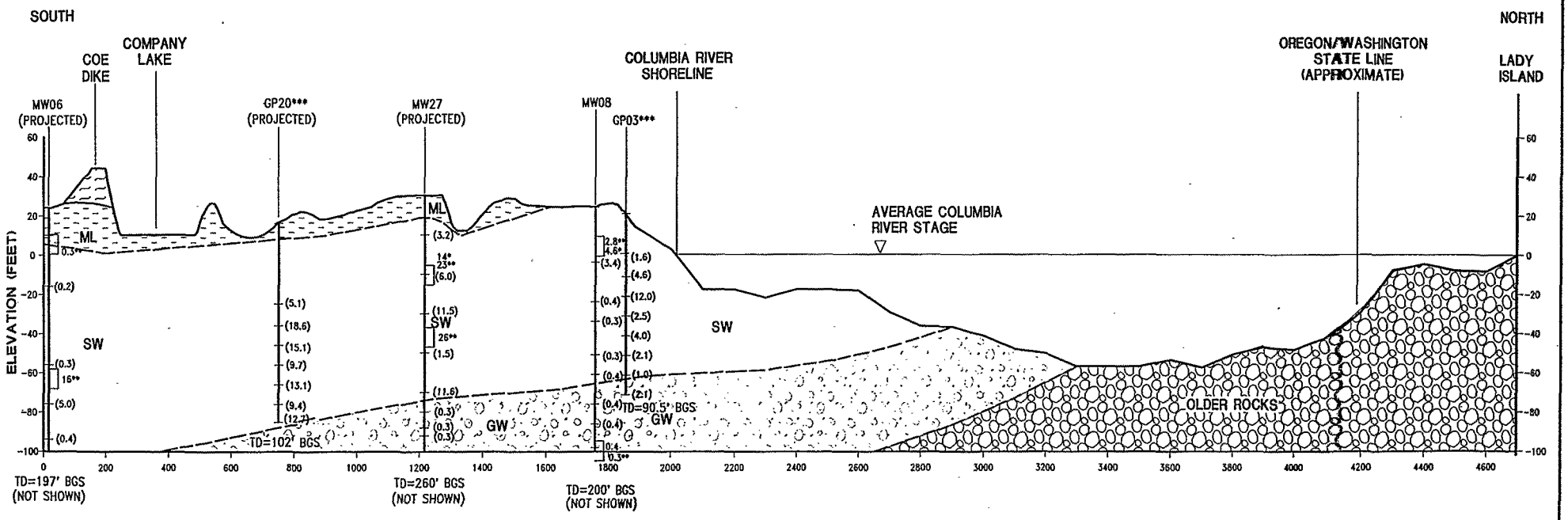


Figure 3-19
Water Chemistry in the Vicinity of Company Lake
Reynolds Metals Company
Troutdale, Oregon
Groundwater Remedial Investigation Report

01-JUNE-1999



LEGEND

- GW = GRAVEL, WELL GRADED
- SW = SAND, WELL GRADED
- ML = SILT
- OLDER ROCKS = VOLCANIC ROCKS, LIKELY SKAMANIA VOLCANIC SERIES (CROPS OUT ON LADY ISLAND, LONE REEF)
- GEOLOGIC BOUNDARIES (APPROXIMATE)

VERTICAL SCALE: 1"=50'
HORIZONTAL SCALE: 1"=400'

NOTES:

- ( ) FIELD MEASURED FLUORIDE CONCENTRATION OBTAINED FROM SCREENING BOREHOLE WATER SAMPLES WITH AN ORION FLUORIDE PROBE DURING PHASES 1 and 1A (FROM APRIL TO DECEMBER 1996) AND GEOPROBE INSTALLATIONS DURING SPRING/SUMMER 1997
- * NOVEMBER 1996 LAB-MEASURED FLUORIDE CONCENTRATION DATA (mg/L)
- ** AUGUST 1997 LAB-MEASURED FLUORIDE CONCENTRATION DATA (mg/L)
- *** NO STRATIGRAPHIC DATA WERE COLLECTED AT GP20 AND GP03
- BGS BELOW THE GROUND SURFACE
- COE U.S. ARMY CORPS OF ENGINEERS
- TD TOTAL DEPTH OF WELL OR GEOPROBE IN FEET BELOW GROUND SURFACE ELEVATION

BATHYMETRIC SURVEY SOURCE:
CHANNEL STATUS COLUMBIA RIVER-MOUTH OF THE COLUMBIA TO BONNEVILLE DAM, US ARMY CORPS OF ENGINEERS, FEBRUARY 1997

VERTICAL EXAGGERATION: 8X
ELEVATION RELATIVE TO THE 1929 NGVD

Figure 3-20
SCHEMATIC GEOLOGIC AND BATHYMETRIC CROSS SECTION FOR COLUMBIA RIVER (CORPS OF ENGINEERS DIKE TO NORTHERN SHORELINE)
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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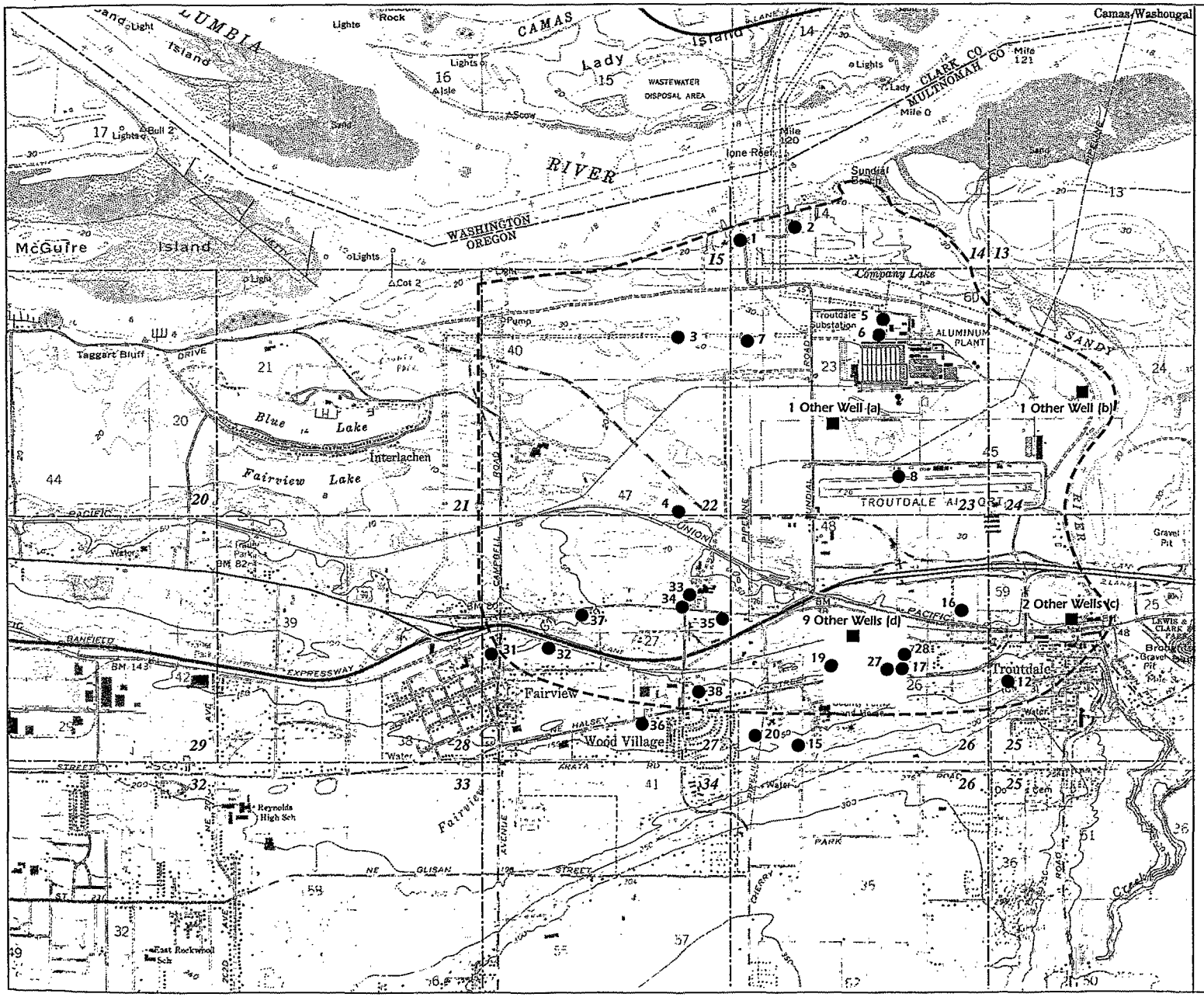

LEGEND

19 ●	Well identified by Oregon Water Resources Department (OWRD) according to well inventory number (WIN). Water wells located within a 1-mile radius of site (see Table 3-10 and Appendix D). Wells located to the nearest 1/4–1/4 section.
9 Other Wells ■	Number of wells in this section identified by OWRD water well reports and potentially located within 1-mile radius of site (see Table 3-10 and Appendix D). Exact locations are unknown. (a) WIN-9 (b) WIN-11 (c) WIN-13, WIN-14 (d) WIN-18, WIN-21, WIN-22, WIN-23, WIN-24, WIN-25, WIN-26, WIN-29, WIN-30
- - - - -	Approximate 1-mile radius around industrial site boundary, Columbia River to the north, and Sandy River to the east.

Notes:

1. Wells identified outside the 1-mile radius are used for hydrogeologic cross section information. OWRD well reports are provided in Appendix D.
2. Rivers are assumed to be boundaries to groundwater flow. No water wells considered if located on east side of Sandy River or north side of Columbia River.

Base map: U.S. Geological Survey 7.5 minute Camas, Washington Quadrangle. Photo revised 1970 and 1975. Contour interval: 10 feet.

NORTH

0 2,000 Feet
Approximate Scale

Figure 3-21
LOCATION MAP FOR OFFSITE WATER WELLS LOCATED WITHIN A 1-MILE RADIUS OF RMC SITE
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

CRAMPHILL

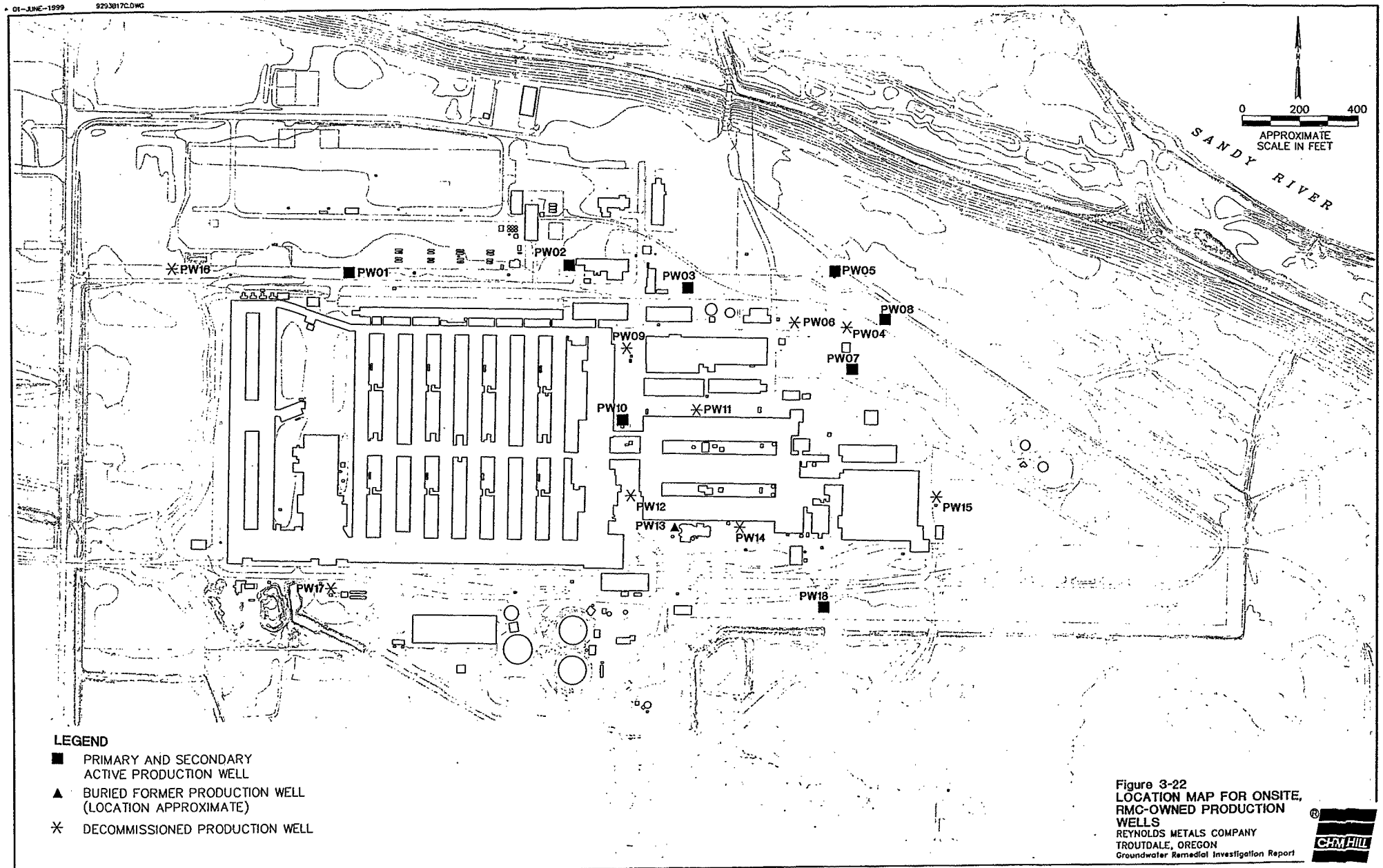

Figure 3-22
LOCATION MAP FOR ONSITE, RMC-OWNED PRODUCTION WELLS
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

SECTION 4

Nature and Extent of Constituents of Potential Concern

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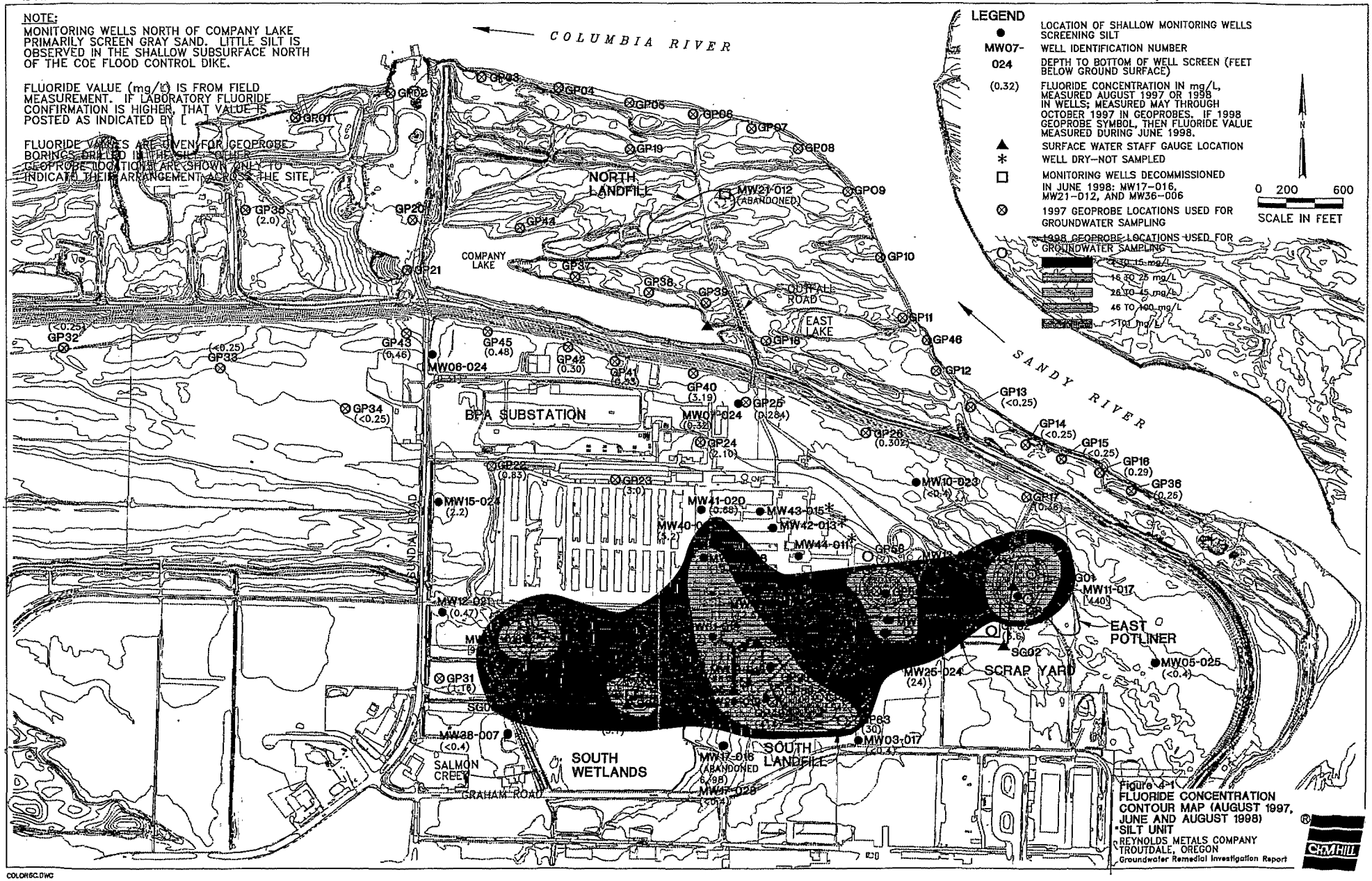
13-MAY-199



COLOR6C.DWG

SRB COLOR2C.DWG
13-MAY-1999

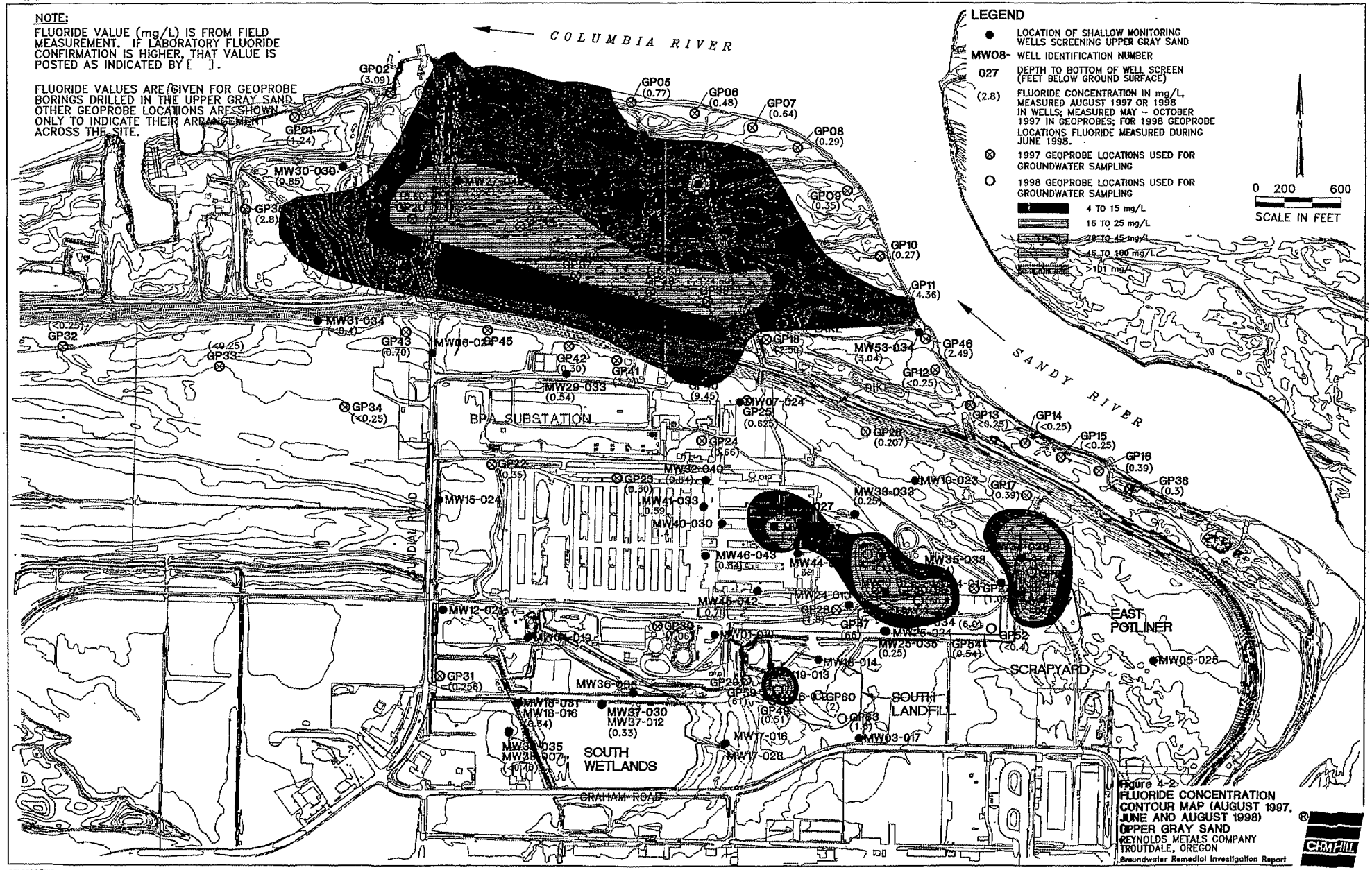


Figure 4-2.
FLUORIDE CONCENTRATION CONTOUR MAP (AUGUST 1997, JUNE AND AUGUST 1998) UPPER GRAY SAND
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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COLOR2C.DWG

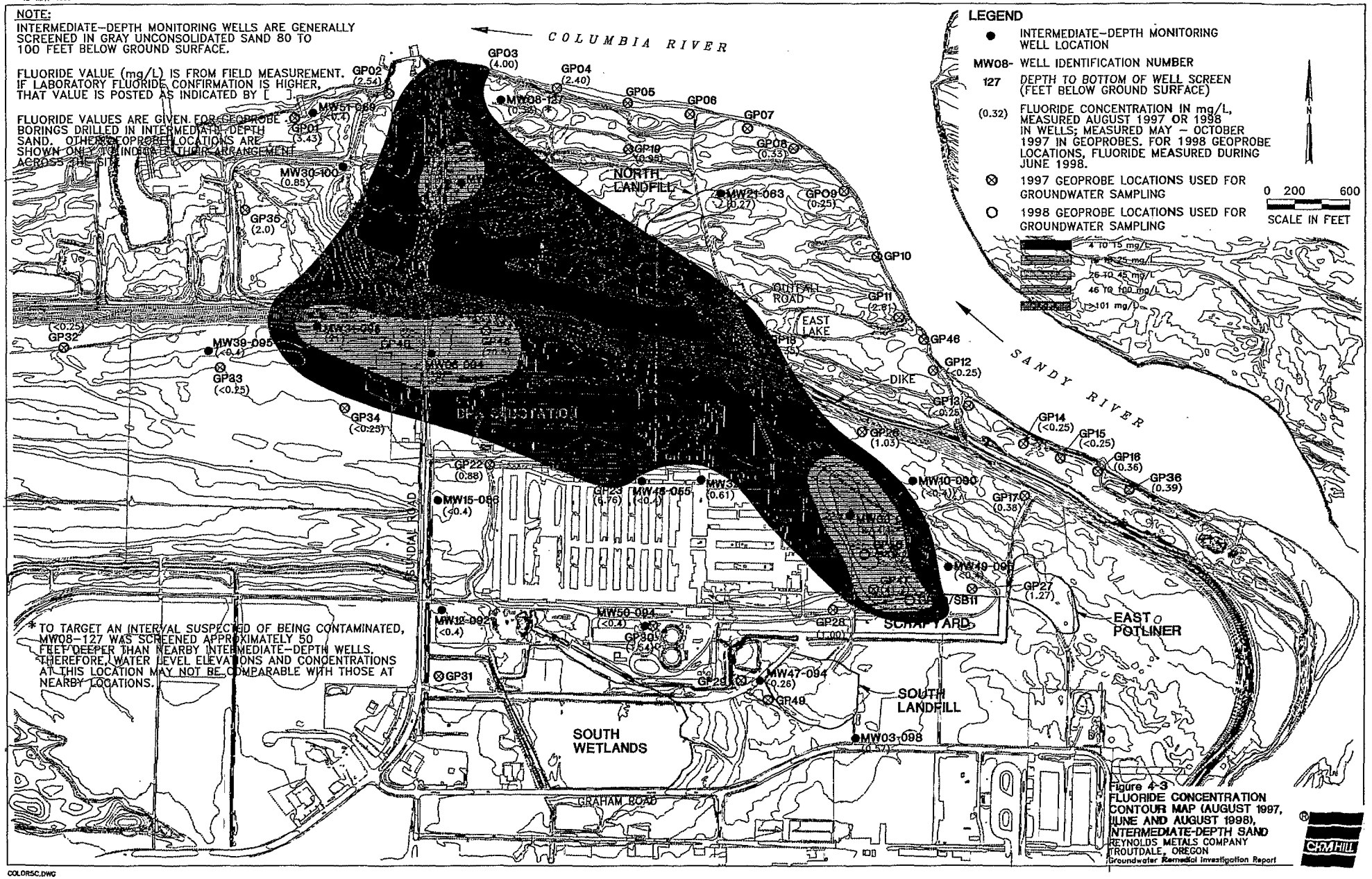

Figure 4-3
FLUORIDE CONCENTRATION CONTOUR MAP (AUGUST 1997, JUNE AND AUGUST 1998), INTERMEDIATE-DEPTH SAND
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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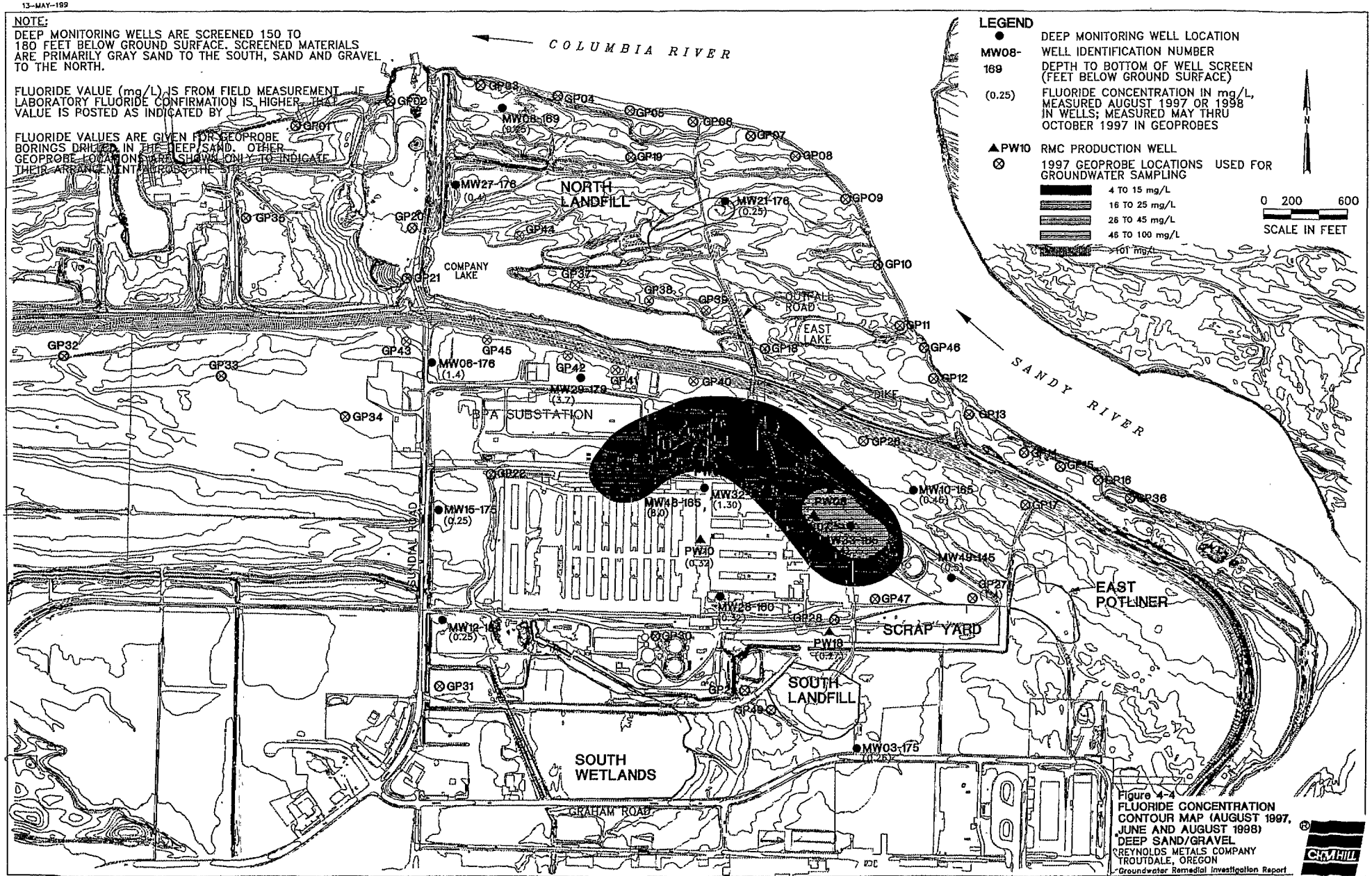
SRB COLOR4C.DWG
13-MAY-199
NOTE:
DEEP MONITORING WELLS ARE SCREENED 150 TO 180 FEET BELOW GROUND SURFACE. SCREENED MATERIALS ARE PRIMARILY GRAY SAND TO THE SOUTH, SAND AND GRAVEL TO THE NORTH.
FLUORIDE VALUE (mg/L) IS FROM FIELD MEASUREMENT. IF LABORATORY FLUORIDE CONFIRMATION IS HIGHER, THAT VALUE IS POSTED AS INDICATED BY
FLUORIDE VALUES ARE GIVEN FOR GEOPROBE BORINGS DRILLED IN THE DEEP SAND. OTHER GEOPROBE LOCATIONS ARE SHOWN ONLY TO INDICATE THEIR ARRANGEMENT ACROSS THE SITE.
COLUMBIA RIVER
LEGEND
DEEP MONITORING WELL LOCATION
MW08- WELL IDENTIFICATION NUMBER
169 DEPTH TO BOTTOM OF WELL SCREEN (FEET BELOW GROUND SURFACE)
(0.25) FLUORIDE CONCENTRATION IN mg/L, MEASURED AUGUST 1997 OR 1998 IN WELLS; MEASURED MAY THRU OCTOBER 1997 IN GEOPROBES
PW10 RMC PRODUCTION WELL
1997 GEOPROBE LOCATIONS USED FOR GROUNDWATER SAMPLING
4 TO 15 mg/L
16 TO 25 mg/L
26 TO 45 mg/L
46 TO 100 mg/L
>101 mg/L
N
0 200 600
SCALE IN FEET
NORTH LANDFILL
COMPANY LAKE
OUTFALL ROAD
EAST LAKE
DIKE
SANDY RIVER
BPA SUBSTATION
PONDAL ROAD
EAST POTLINER
SCRAP YARD
SOUTH LANDFILL
SOUTH WETLANDS
GRAHAM ROAD
GP01 GP02 GP03 GP04 GP05 GP06 GP07 GP08 GP09 GP10 GP11 GP12 GP13 GP14 GP15 GP16 GP17 GP18 GP19 GP20 GP21 GP22 GP23 GP24 GP25 GP26 GP27 GP28 GP29 GP30 GP31 GP32 GP33 GP34 GP35 GP36 GP37 GP38 GP39 GP40 GP41 GP42 GP43 GP45 GP46 GP47 GP48 GP49
MW08-169 (0.25)
MW27-176 (0.4)
MW21-176 (0.25)
MW08-176 (1.4)
MW29-179 (3.7)
MW15-175 (0.25)
MW48-165 (8.0)
MW32 (1.30)
PW10 (0.32)
MW10-165 (0.46)
MW49-145 (0.5)
MW28-160 (0.32)
MW12-165 (0.25)
PW18 (0.42)
MW03-175 (0.25)
Figure 4-4
FLUORIDE CONCENTRATION CONTOUR MAP (AUGUST 1997, JUNE AND AUGUST 1998) DEEP SAND/GRAVEL
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report
CRMHILL
COLOR4C.DWG

SRB
01-JUNE-1999

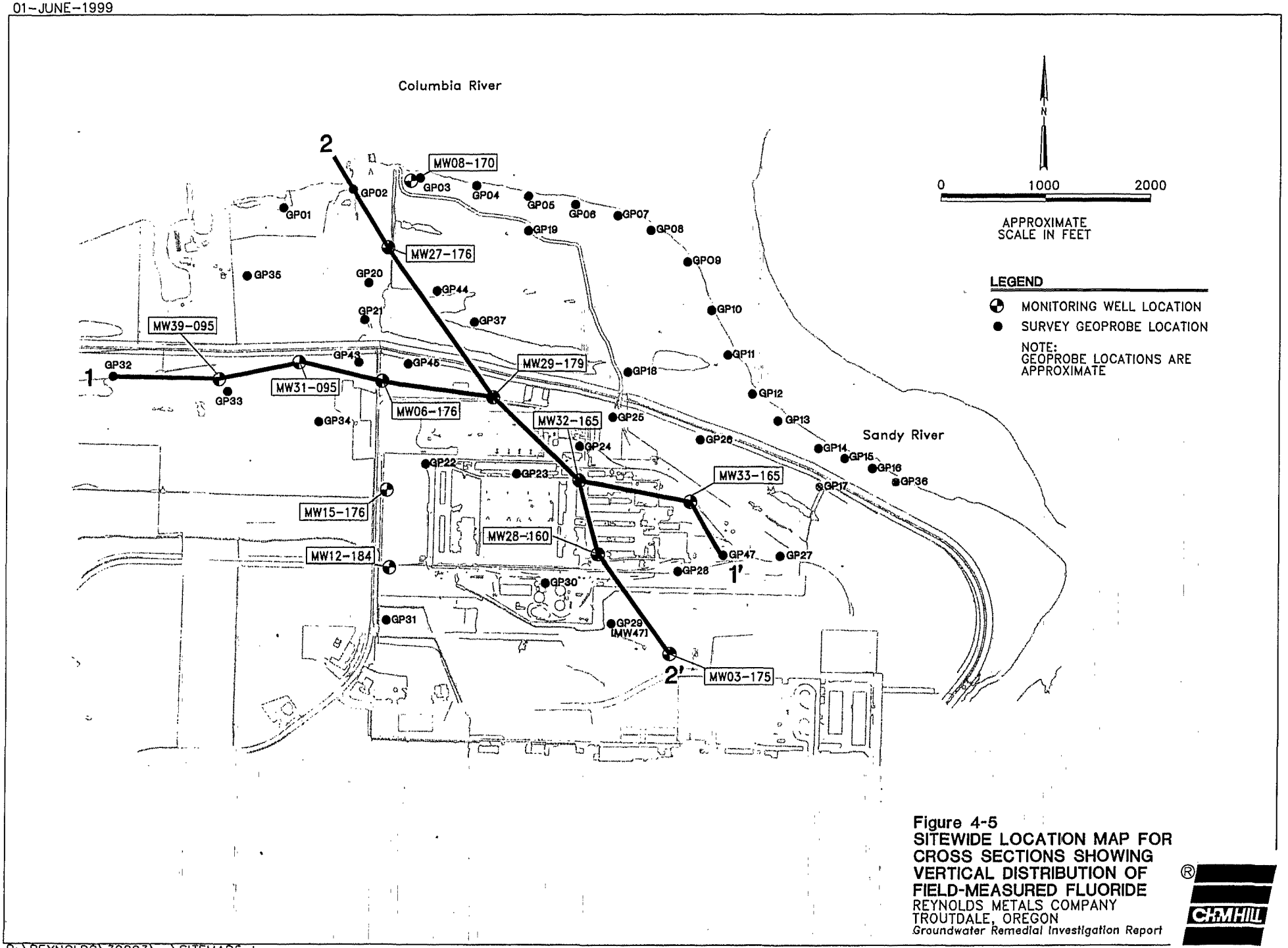

Figure 4-5
SITEWIDE LOCATION MAP FOR CROSS SECTIONS SHOWING VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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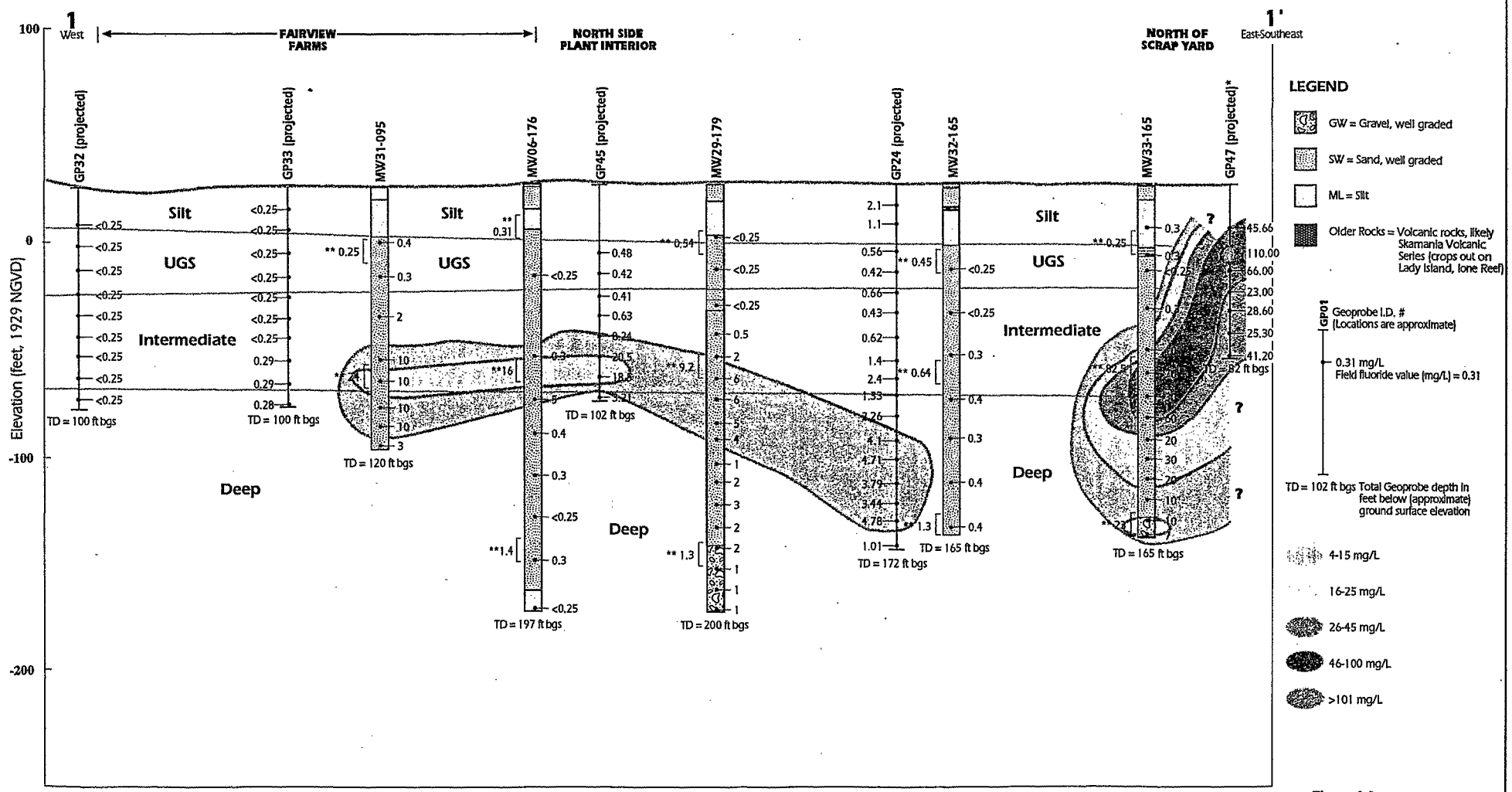

Notes: Values next to well columns indicate fluoride concentrations measured during drilling of the identified well. In most cases the well column represents a composite log, whose screened intervals are shown by a bracket to the left of the column.

Field-measured fluoride concentrations were obtained by screening borehole water samples with an Orion fluoride probe during Phase 1 and Phase 1A drilling (April 1996 to December 1996) and during the Geoprobe investigation (summer 1997).

* Note that the fluoride distribution shown in MW33 and GP47 is localized.

** August 1997 fluoride concentration data (mg/L).

Approximate Scales:
Horizontal scale: **1 inch = 500 feet**
Vertical scale: **1 inch = 45 feet**
Vertical exaggeration: **11x**

Silt, upper gray sand (UGS), intermediate-depth and deep zones represent hydrogeologic units.

Figure 4-6
CROSS SECTION 1-1'
VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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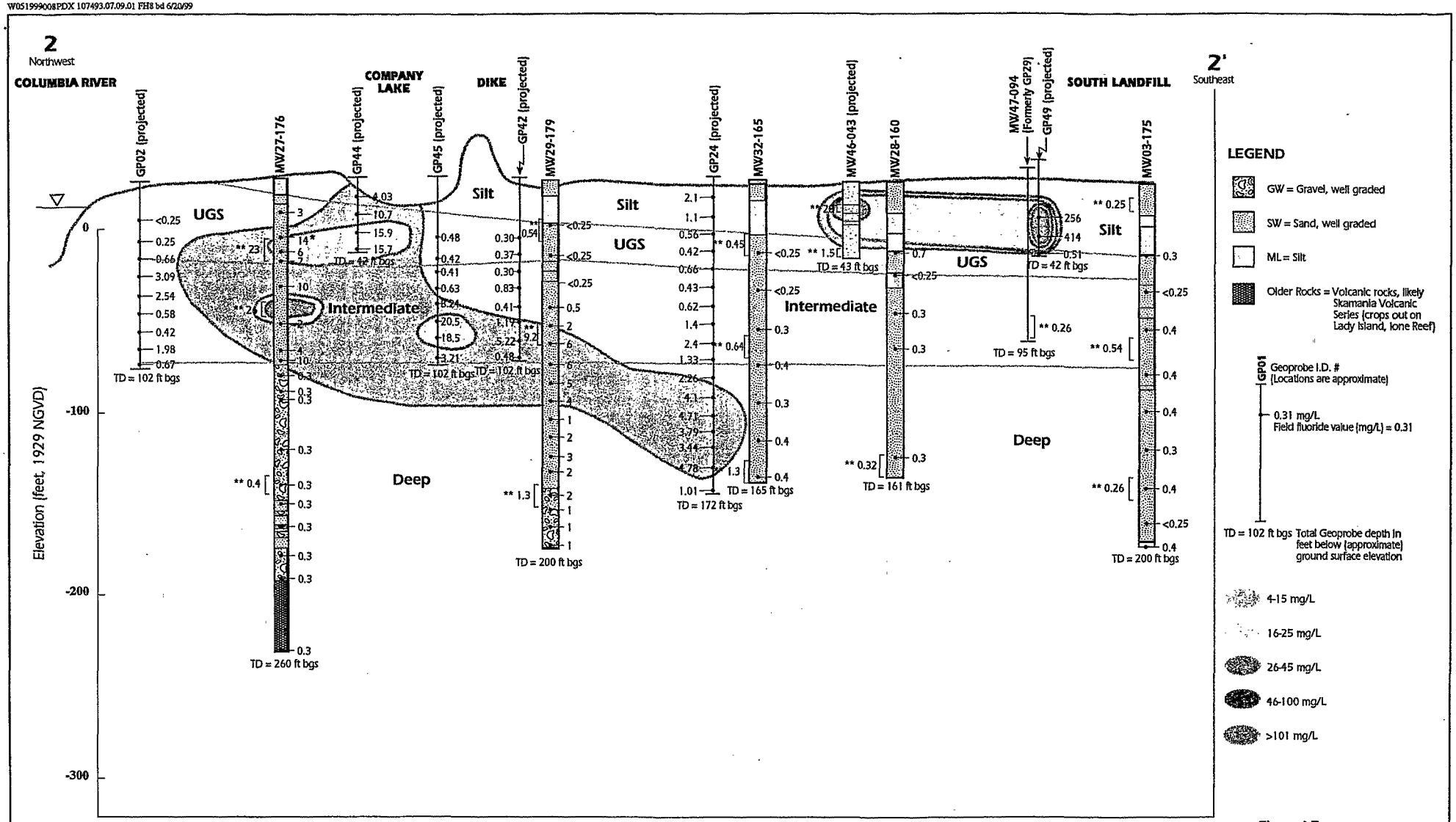

Notes: Values next to well columns indicate fluoride concentrations measured during drilling of the identified well. In most cases the well column represents a composite log, whose screened intervals are shown by a bracket to the left of the column.

Field-measured fluoride concentrations were obtained by screening borehole water samples with an Orion fluoride probe during Phase 1 and Phase 1A drilling (April 1996 to December 1996) and during the Geoprobe investigation (summer 1997).

* November 1996 fluoride concentration from MW27-045 monitoring well.

** August 1997 fluoride concentration data (mg/L).

Approximate Scales:
Horizontal scale: **1 inch = 500 feet**
Vertical scale: **1 inch = 50 feet**
Vertical exaggeration: **10x**

Silt, upper gray sand (UGS), intermediate-depth and deep zones represent hydrogeologic units.

Figure 4-7
CROSS SECTION 2-2'
VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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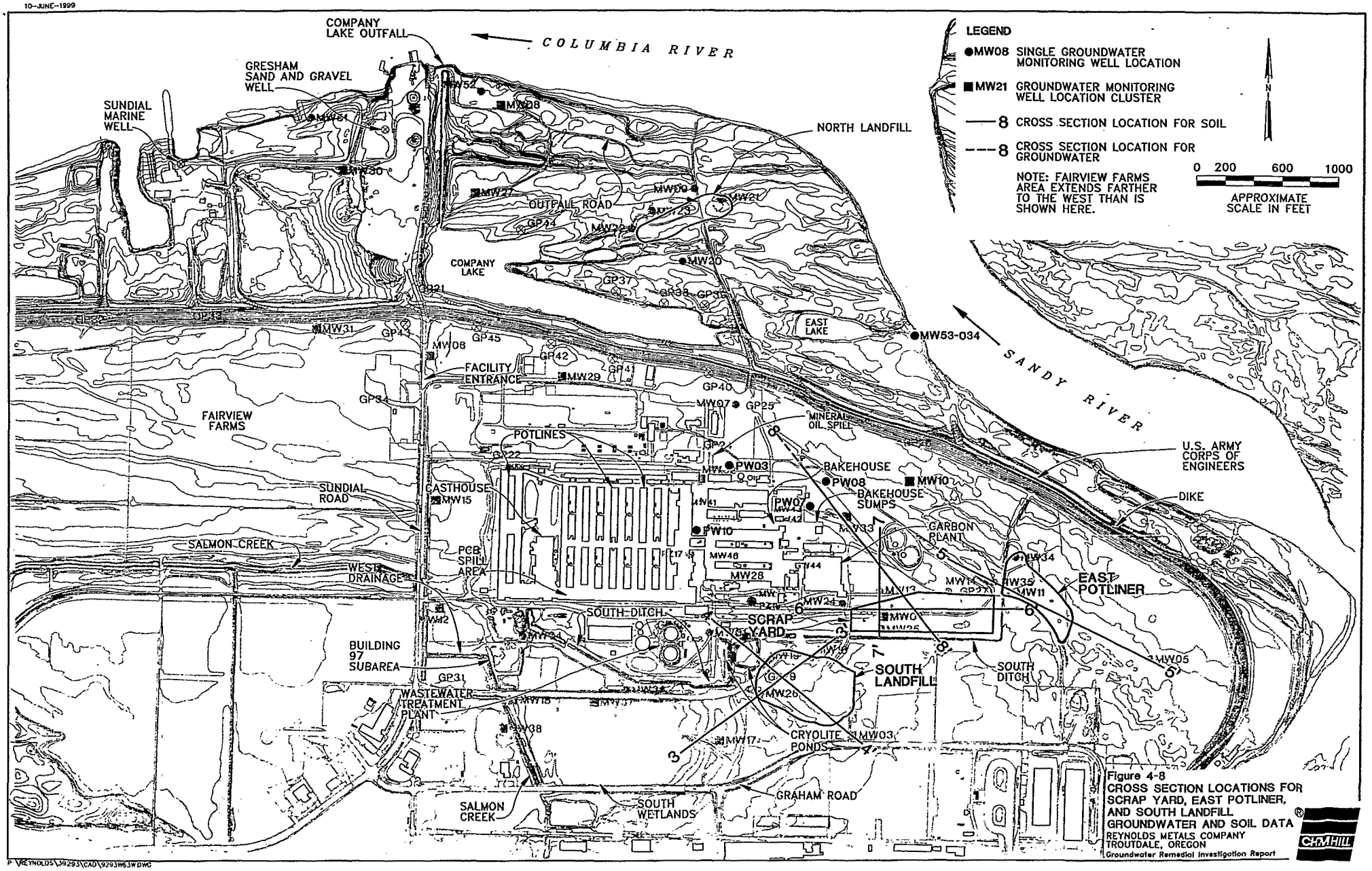

Figure 4-8
CROSS SECTION LOCATIONS FOR SCRAP YARD, EAST POTLINER, AND SOUTH LANDFILL GROUNDWATER AND SOIL DATA
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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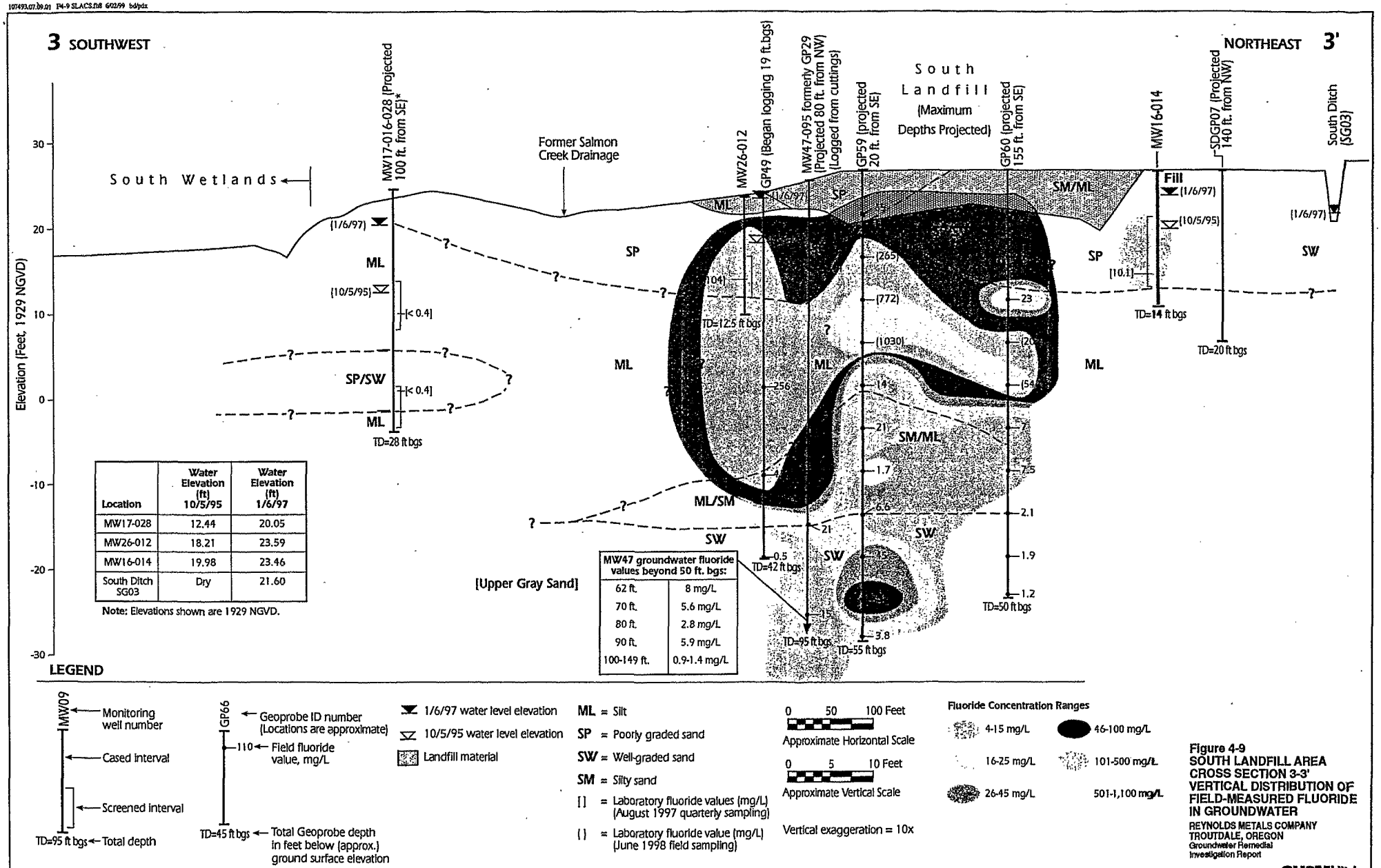

Location	Water Elevation (ft) 10/5/95	Water Elevation (ft) 1/6/97
MW17-028	12.44	20.05
MW26-012	18.21	23.59
MW16-014	19.98	23.46
South Ditch SG03	Dry	21.60

Note: Elevations shown are 1929 NGVD.

MW47 groundwater fluoride values beyond 50 ft. bgs:	
62 ft.	8 mg/L
70 ft.	5.6 mg/L
80 ft.	2.8 mg/L
90 ft.	5.9 mg/L
100-149 ft.	0.9-1.4 mg/L

LEGEND

MW09 ← Monitoring well number
Cased interval
Screened interval
TD=95 ft bgs ← Total depth

GP66 ← Geoprobe ID number (Locations are approximate)
110 ← Field fluoride value, mg/L
TD=45 ft bgs ← Total Geoprobe depth in feet below (approx.) ground surface elevation

1/6/97 water level elevation
10/5/95 water level elevation
Landfill material

ML = Silt
SP = Poorly graded sand
SW = Well-graded sand
SM = Silty sand
[ ] = Laboratory fluoride values (mg/L) (August 1997 quarterly sampling)
( ) = Laboratory fluoride value (mg/L) (June 1998 field sampling)

0 50 100 Feet
Approximate Horizontal Scale
0 5 10 Feet
Approximate Vertical Scale
Vertical exaggeration = 10x

Fluoride Concentration Ranges
4-15 mg/L
16-25 mg/L
26-45 mg/L
46-100 mg/L
101-500 mg/L
501-1,100 mg/L

Figure 4-9
SOUTH LANDFILL AREA CROSS SECTION 3-3' VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE IN GROUNDWATER
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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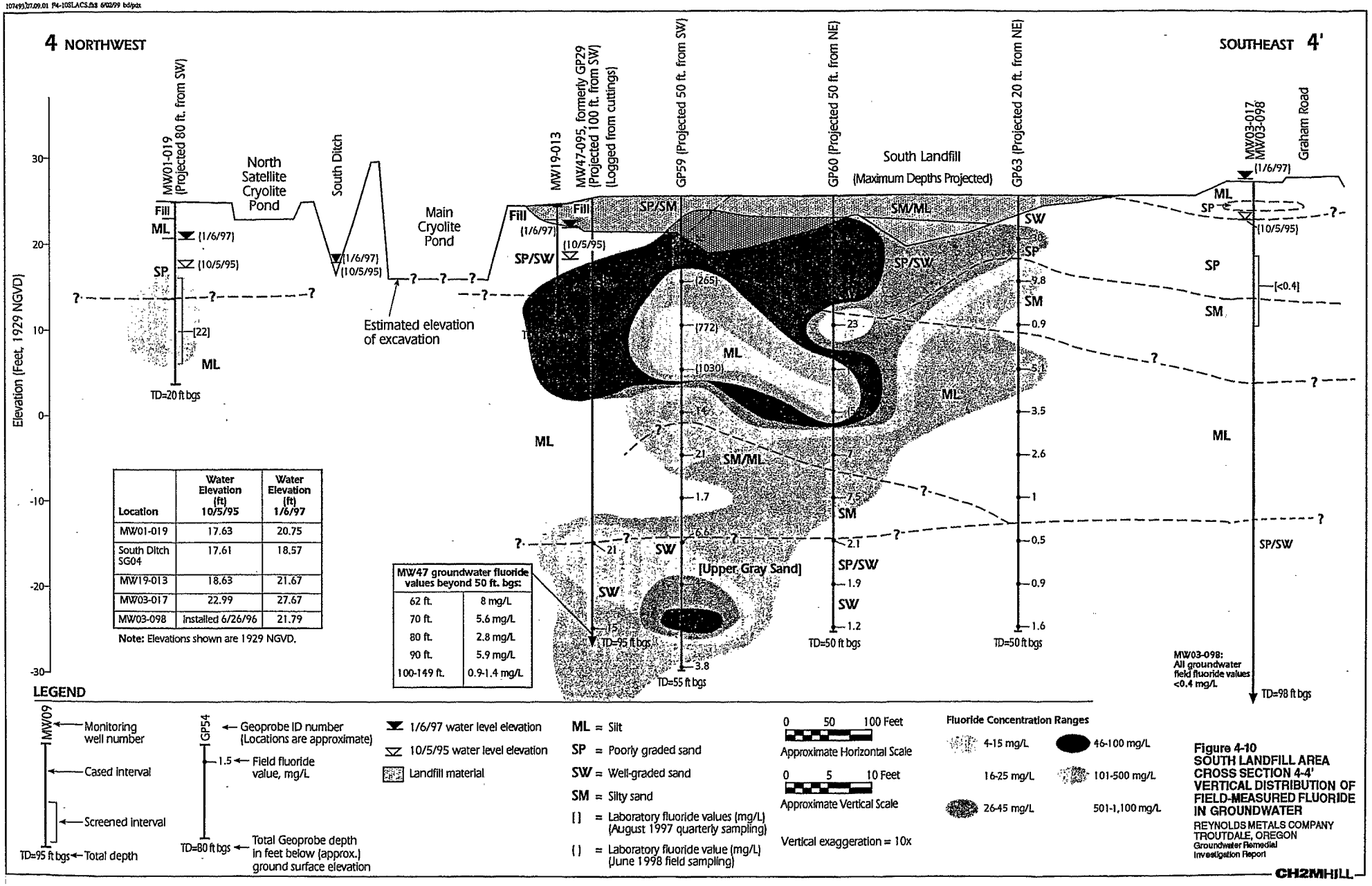

Location	Water Elevation (ft) 10/5/95	Water Elevation (ft) 1/6/97
MW01-019	17.63	20.75
South Ditch SG04	17.61	18.57
MW19-013	18.63	21.67
MW03-017	22.99	27.67
MW03-098	installed 6/26/96	21.79

Note: Elevations shown are 1929 NGVD.

MW47 groundwater fluoride values beyond 50 ft. bgs:	
62 ft.	8 mg/L
70 ft.	5.6 mg/L
80 ft.	2.8 mg/L
90 ft.	5.9 mg/L
100-149 ft.	0.9-1.4 mg/L

Figure 4-10
SOUTH LANDFILL AREA CROSS SECTION 4-4' VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE IN GROUNDWATER
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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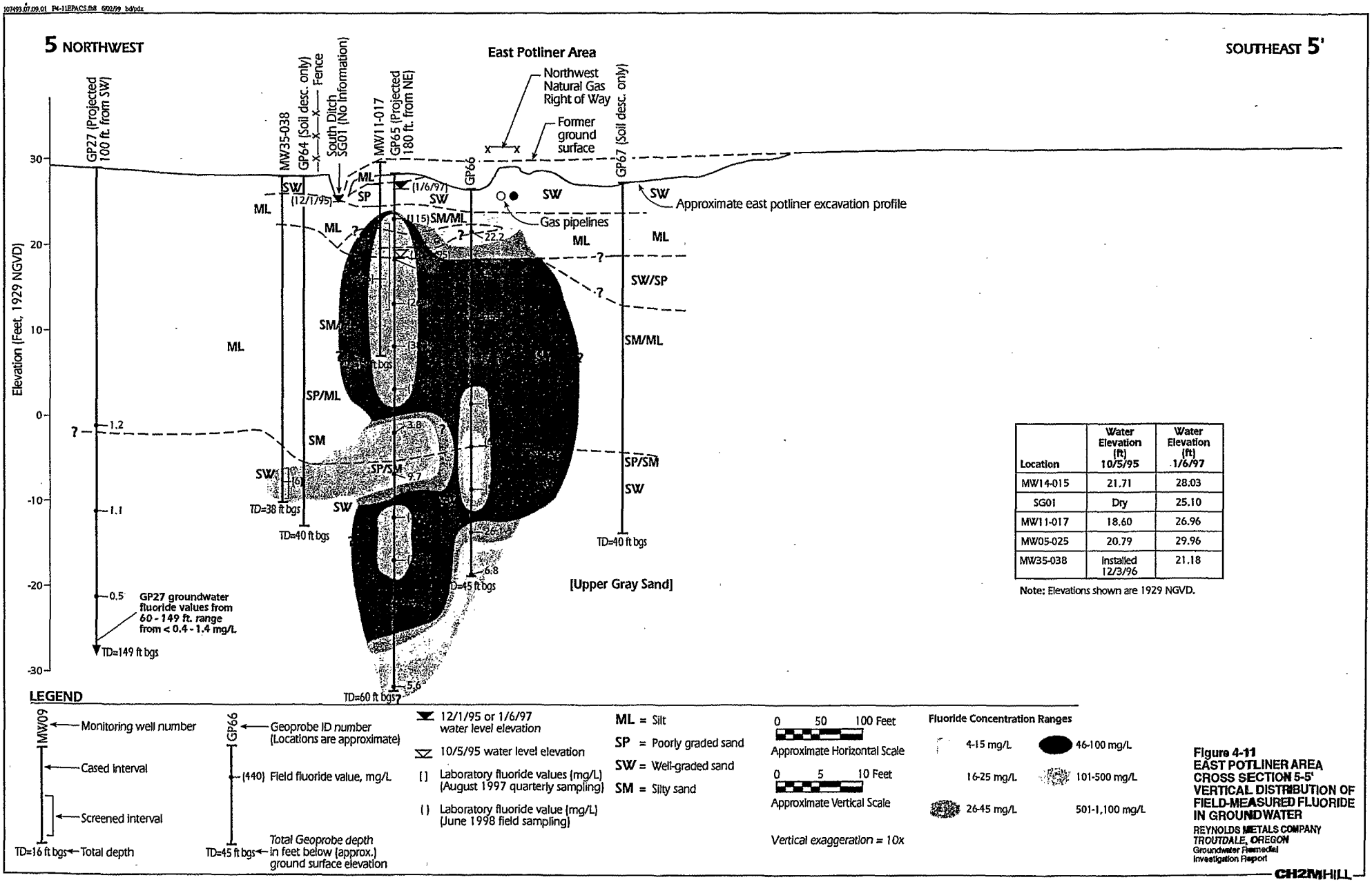

Location	Water Elevation (ft) 10/5/95	Water Elevation (ft) 1/6/97
MW14-015	21.71	28.03
SG01	Dry	25.10
MW11-017	18.60	26.96
MW05-025	20.79	29.96
MW35-038	installed 12/3/96	21.18

Note: Elevations shown are 1929 NGVD.

Figure 4-11
EAST POTLINER AREA CROSS SECTION 5-5' VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE IN GROUNDWATER
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
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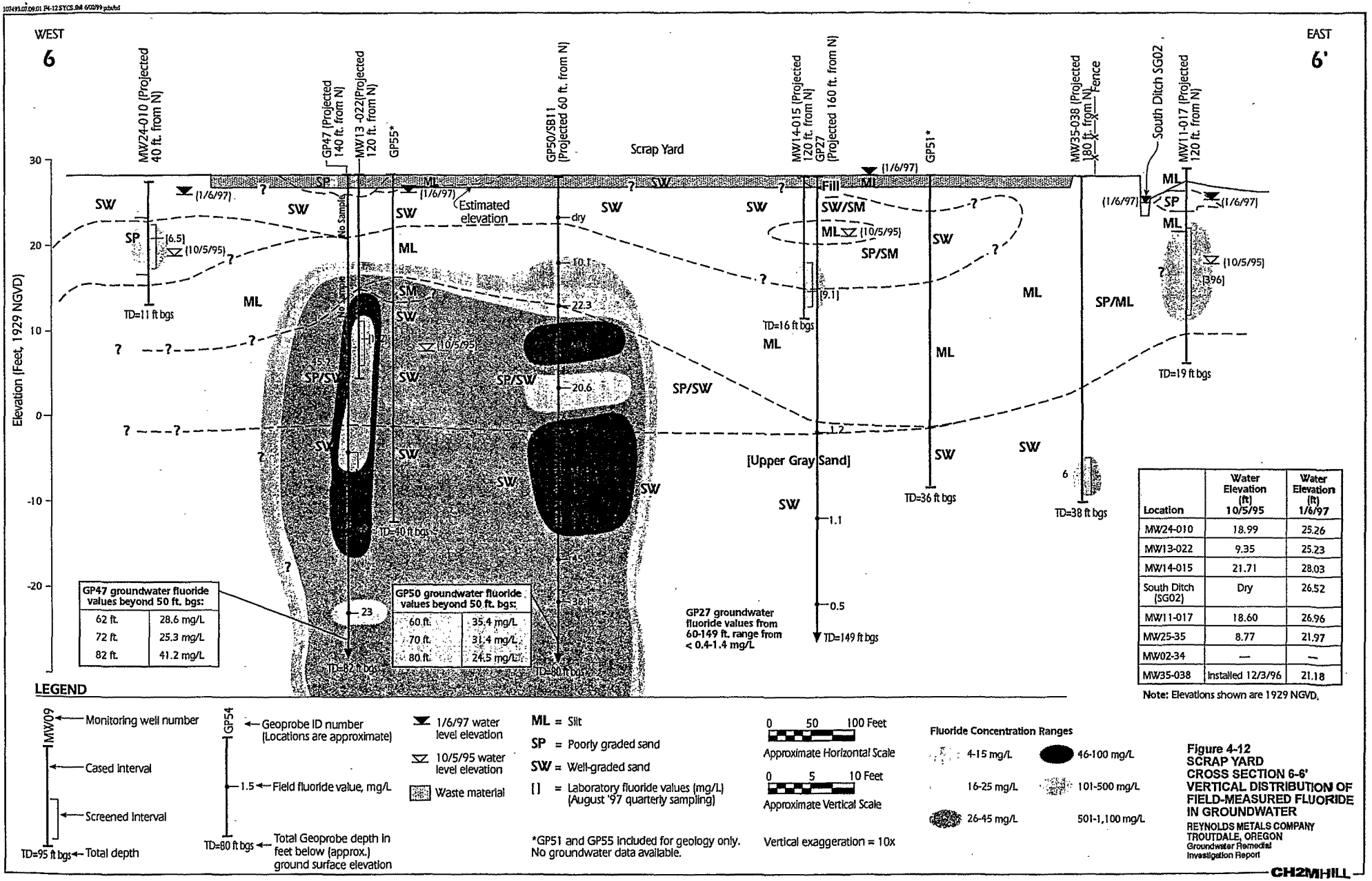

Location	Water Elevation (ft) 10/5/95	Water Elevation (ft) 1/6/97
MW24-010	18.99	25.26
MW13-022	9.35	25.23
MW14-015	21.71	28.03
South Ditch (SG02)	Dry	26.52
MW11-017	18.60	26.96
MW25-35	8.77	21.97
MW02-34	—	—
MW35-038	Installed 12/3/96	21.18

Note: Elevations shown are 1929 NGVD.

Figure 4-12
SCRAP YARD
CROSS SECTION 6-6'
VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE IN GROUNDWATER
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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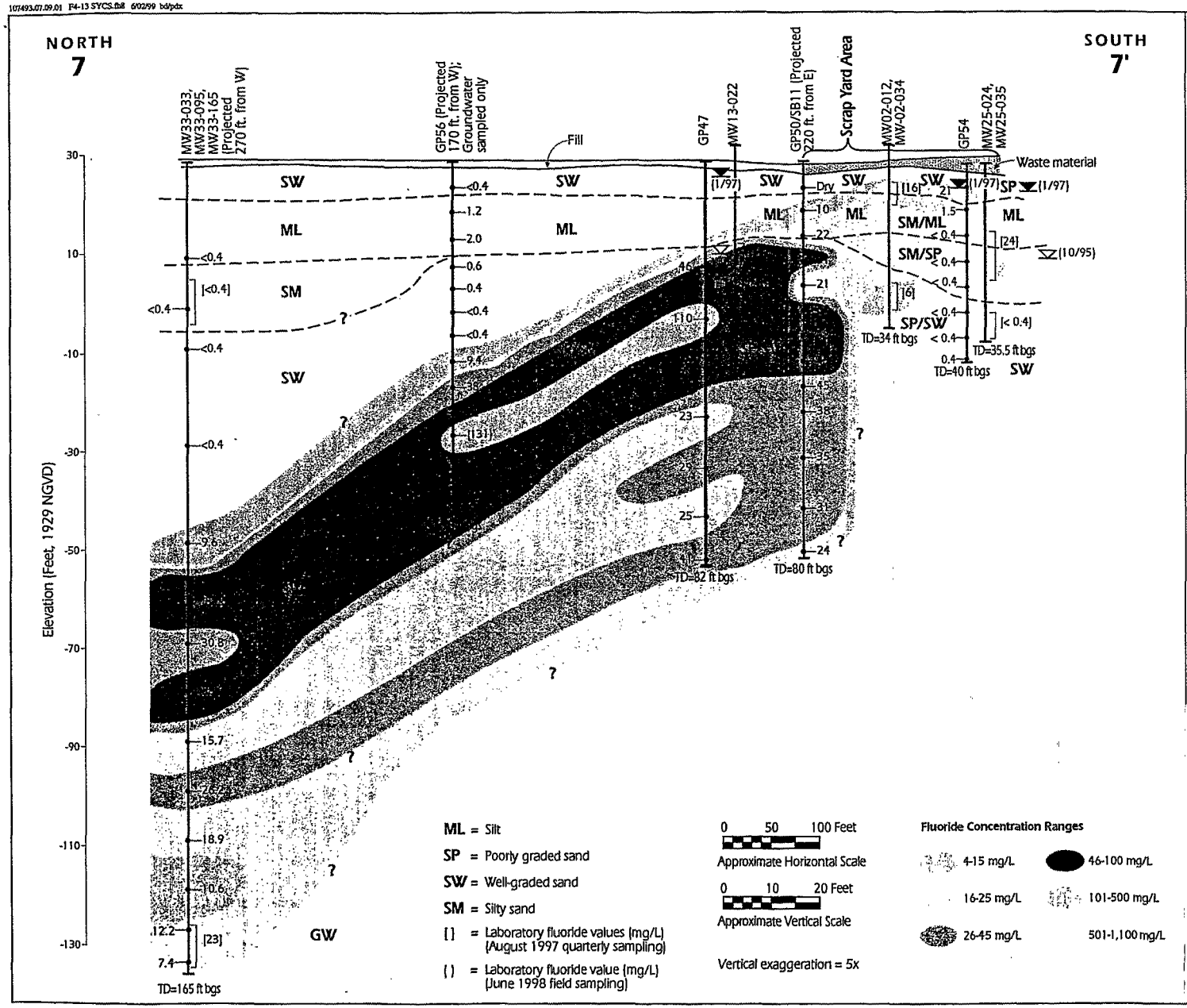
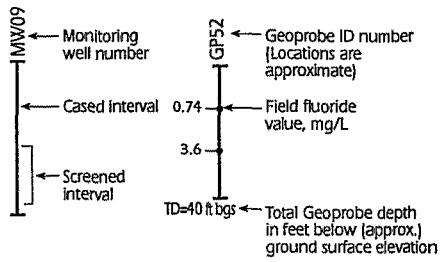


LEGEND



Location	Water Elevation (ft) 10/5/95	Water Elevation (ft) 1/6/97
MW25-035	8.77	21.97
MW02-034	N/A	21.99
MW13-022	9.35	25.23

Note: Elevations shown are 1929 NGVD.

1/6/97 water level elevation

10/5/95 water level elevation

Waste material

Note: MW33 well column represents a group of wells, whose screened intervals are indicated by a bracket to the right of the column.

Figure 4-13
SCRAP YARD
CROSS SECTION 7-7'
VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE IN GROUNDWATER
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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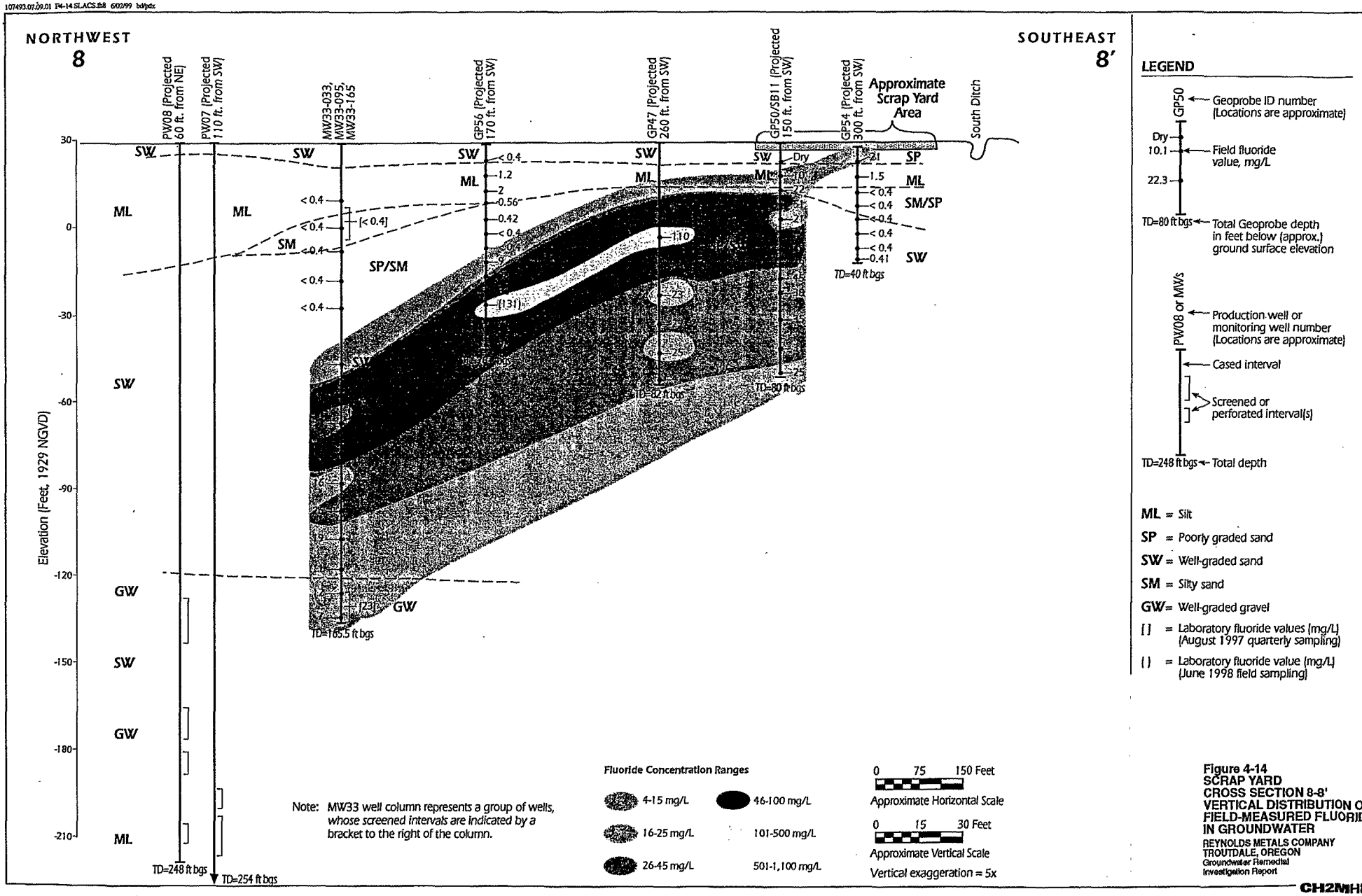

Figure 4-14
SCRAP YARD CROSS SECTION 8-8' VERTICAL DISTRIBUTION OF FIELD-MEASURED FLUORIDE IN GROUNDWATER
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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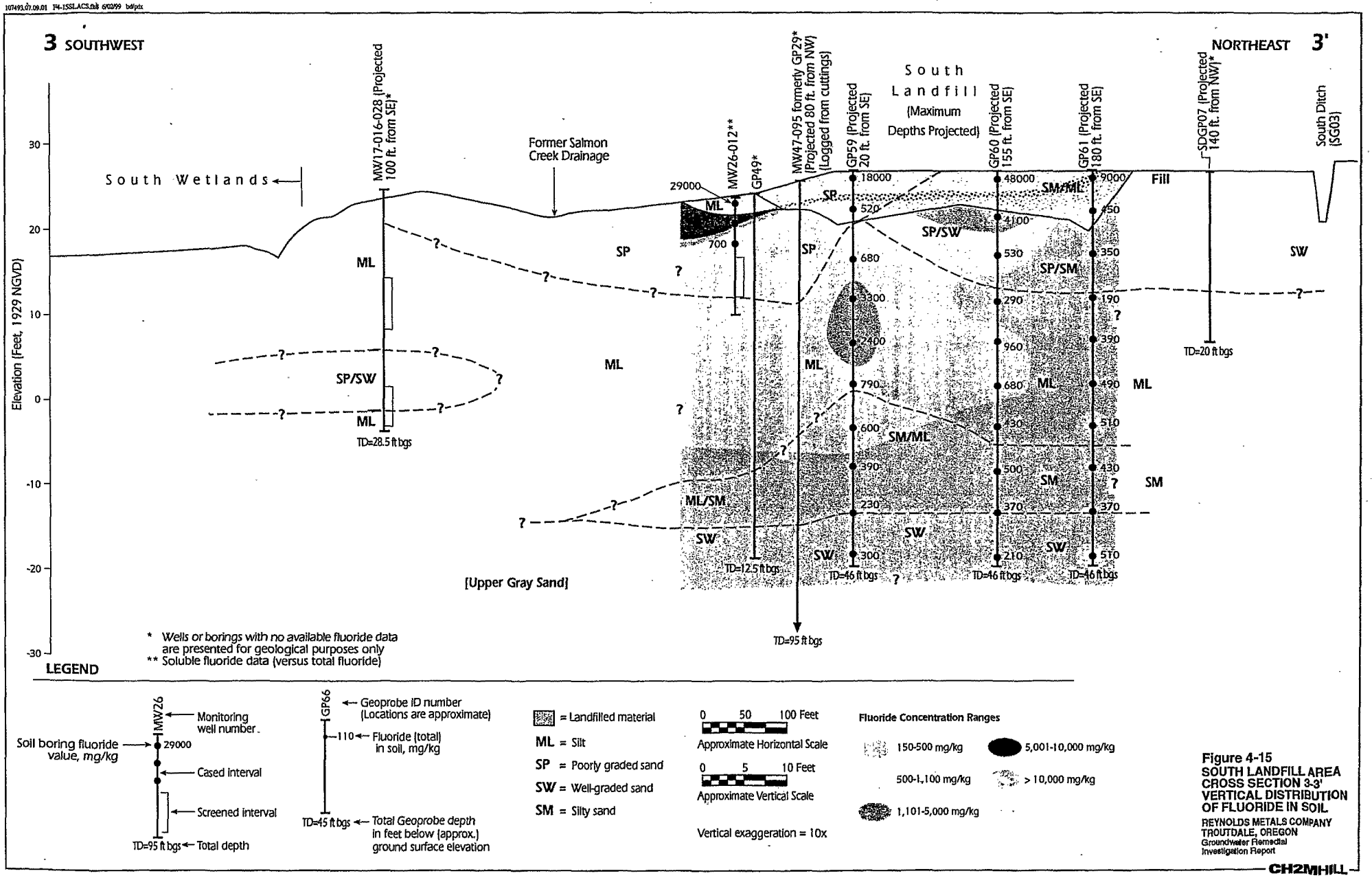

Figure 4-15
SOUTH LANDFILL AREA CROSS SECTION 3-3' VERTICAL DISTRIBUTION OF FLUORIDE IN SOIL
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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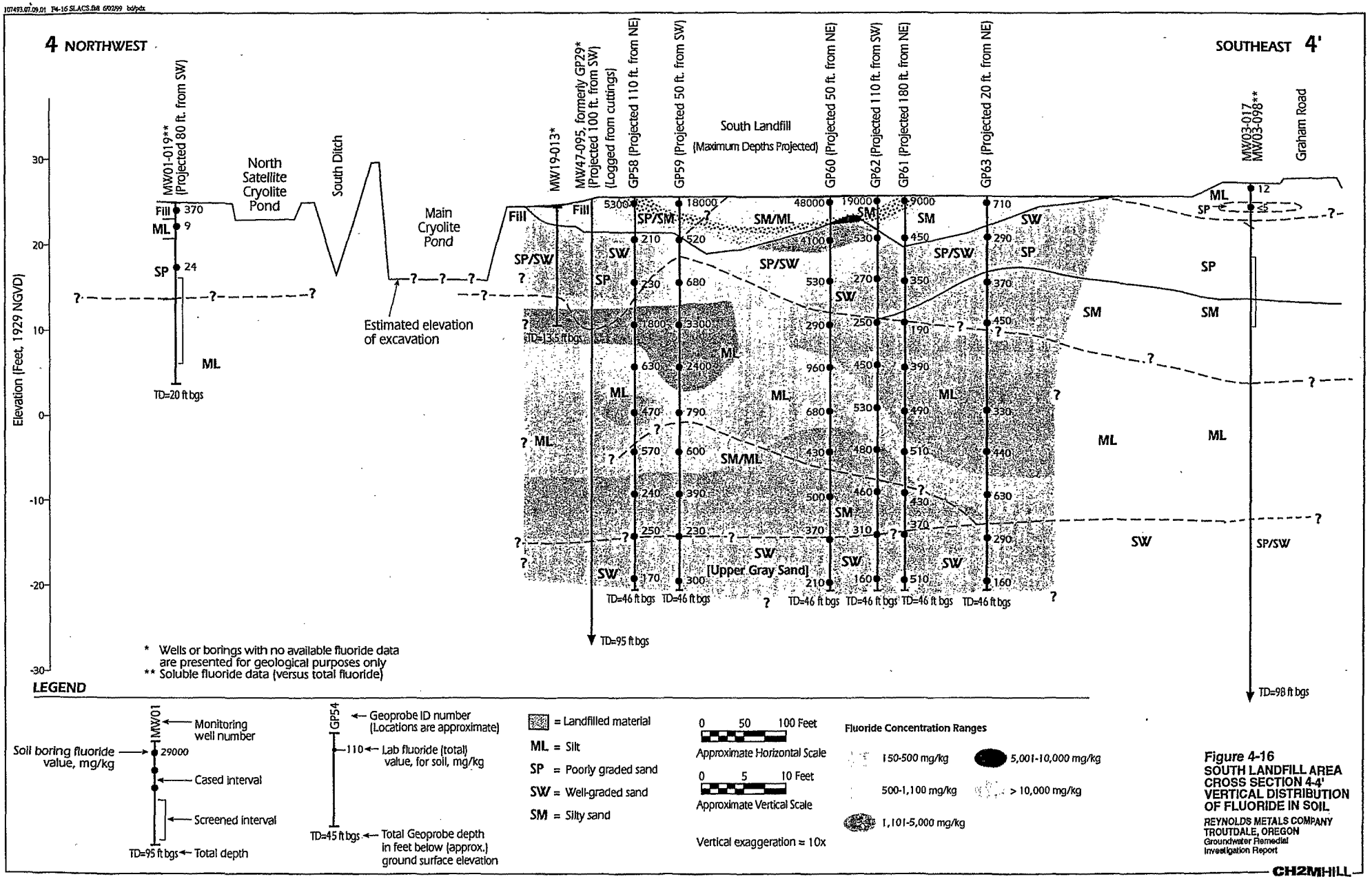

Figure 4-16
SOUTH LANDFILL AREA CROSS SECTION 4-4' VERTICAL DISTRIBUTION OF FLUORIDE IN SOIL
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
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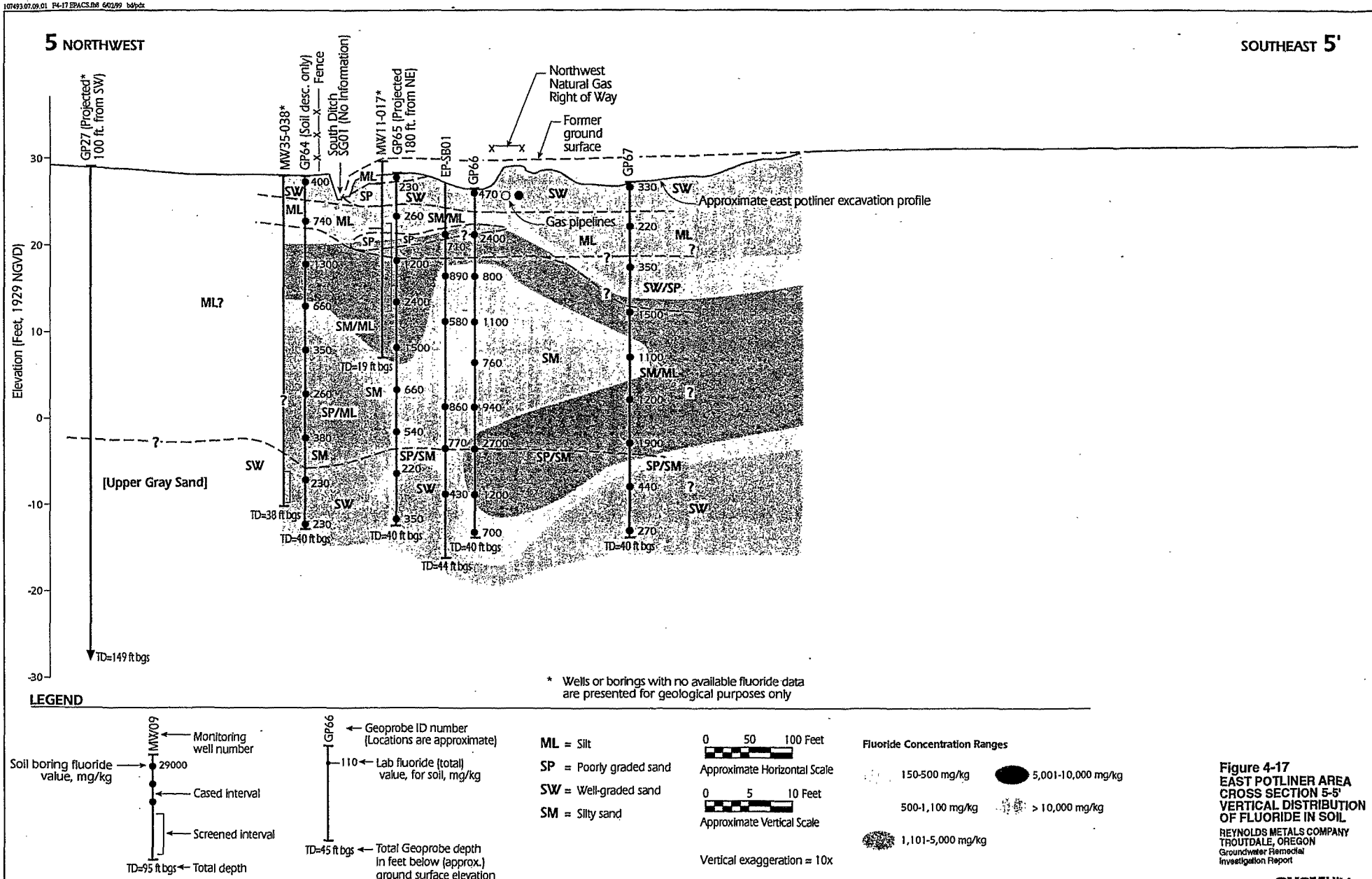

Figure 4-17
EAST POTLINER AREA CROSS SECTION 5-5' VERTICAL DISTRIBUTION OF FLUORIDE IN SOIL
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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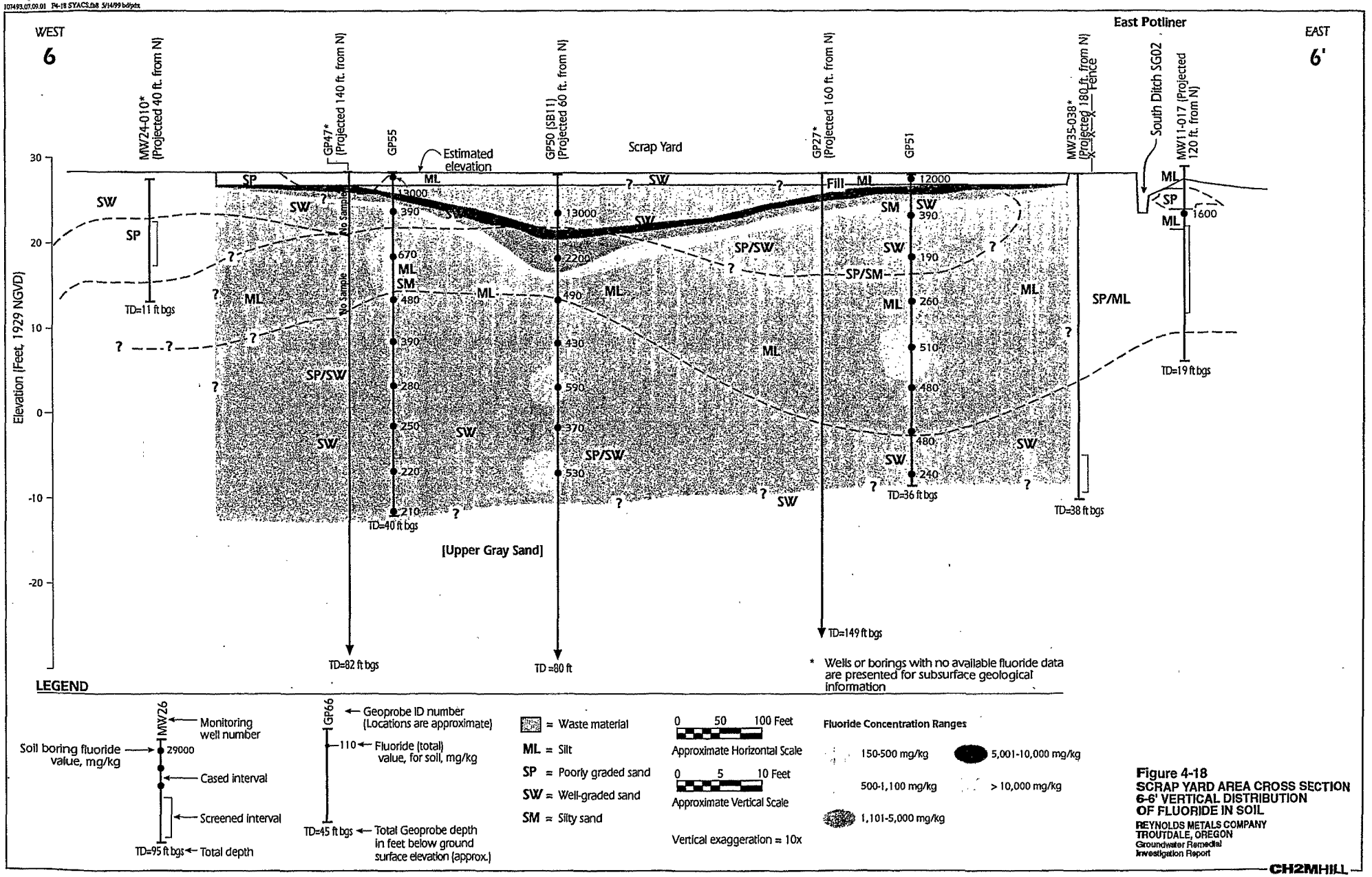

Figure 4-18
SCRAP YARD AREA CROSS SECTION 6-6' VERTICAL DISTRIBUTION OF FLUORIDE IN SOIL
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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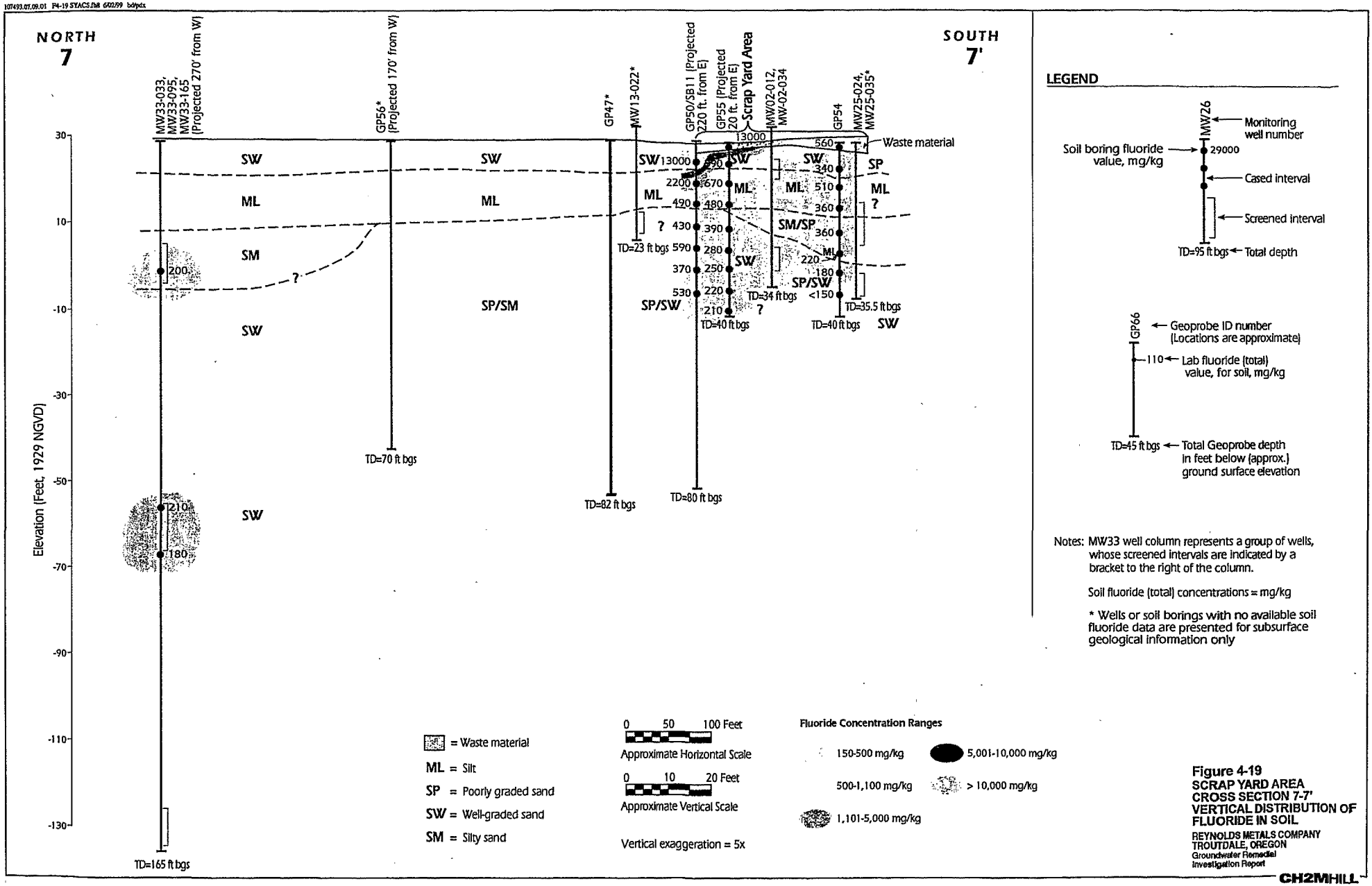

LEGEND

Notes: MW33 well column represents a group of wells, whose screened intervals are indicated by a bracket to the right of the column.

Soil fluoride (total) concentrations = mg/kg

* Wells or soil borings with no available soil fluoride data are presented for subsurface geological information only

Figure 4-19
SCRAP YARD AREA
CROSS SECTION 7-7'
VERTICAL DISTRIBUTION OF FLUORIDE IN SOIL
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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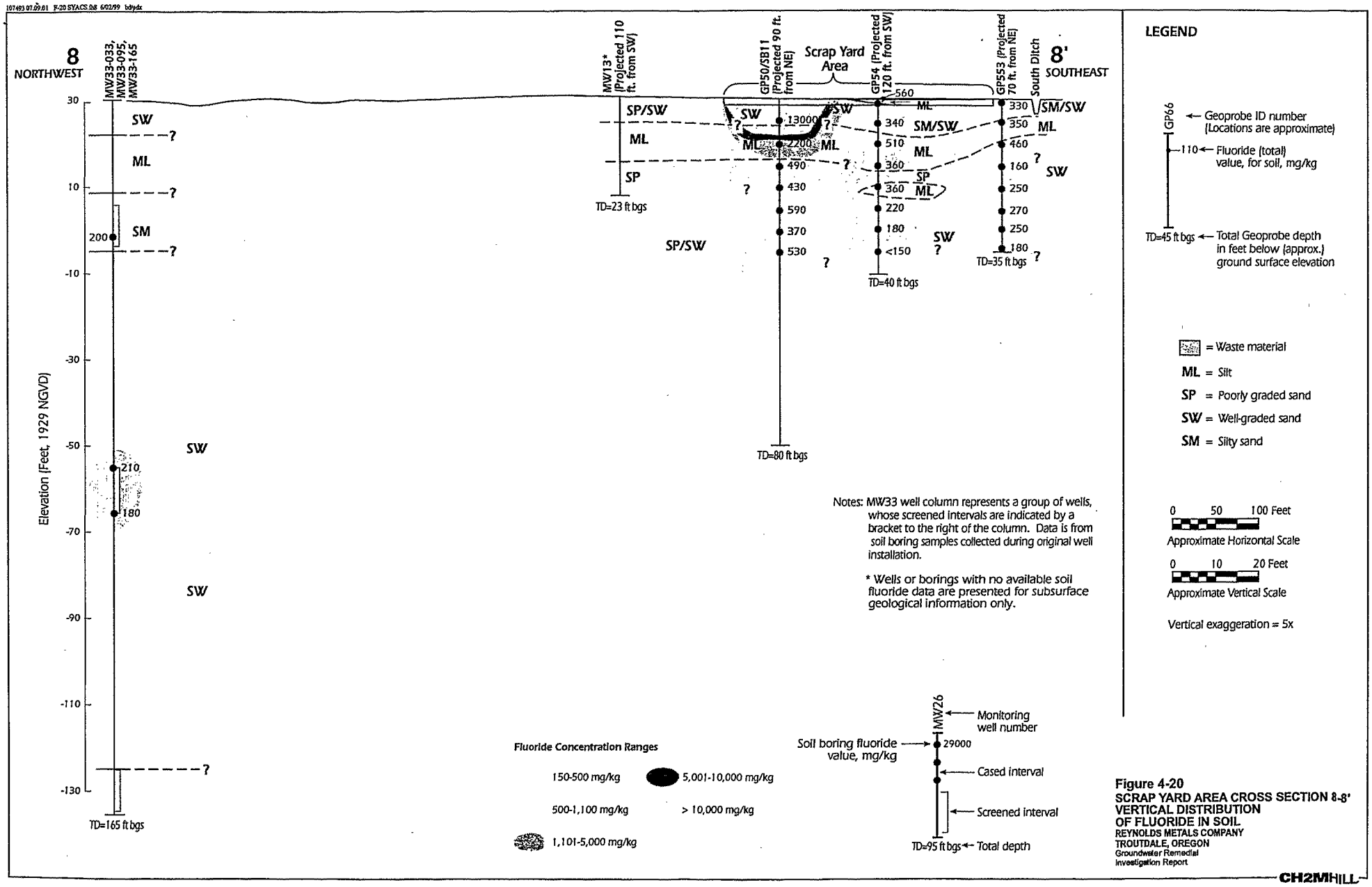

Figure 4-20
SCRAP YARD AREA CROSS SECTION 8-8' VERTICAL DISTRIBUTION OF FLUORIDE IN SOIL
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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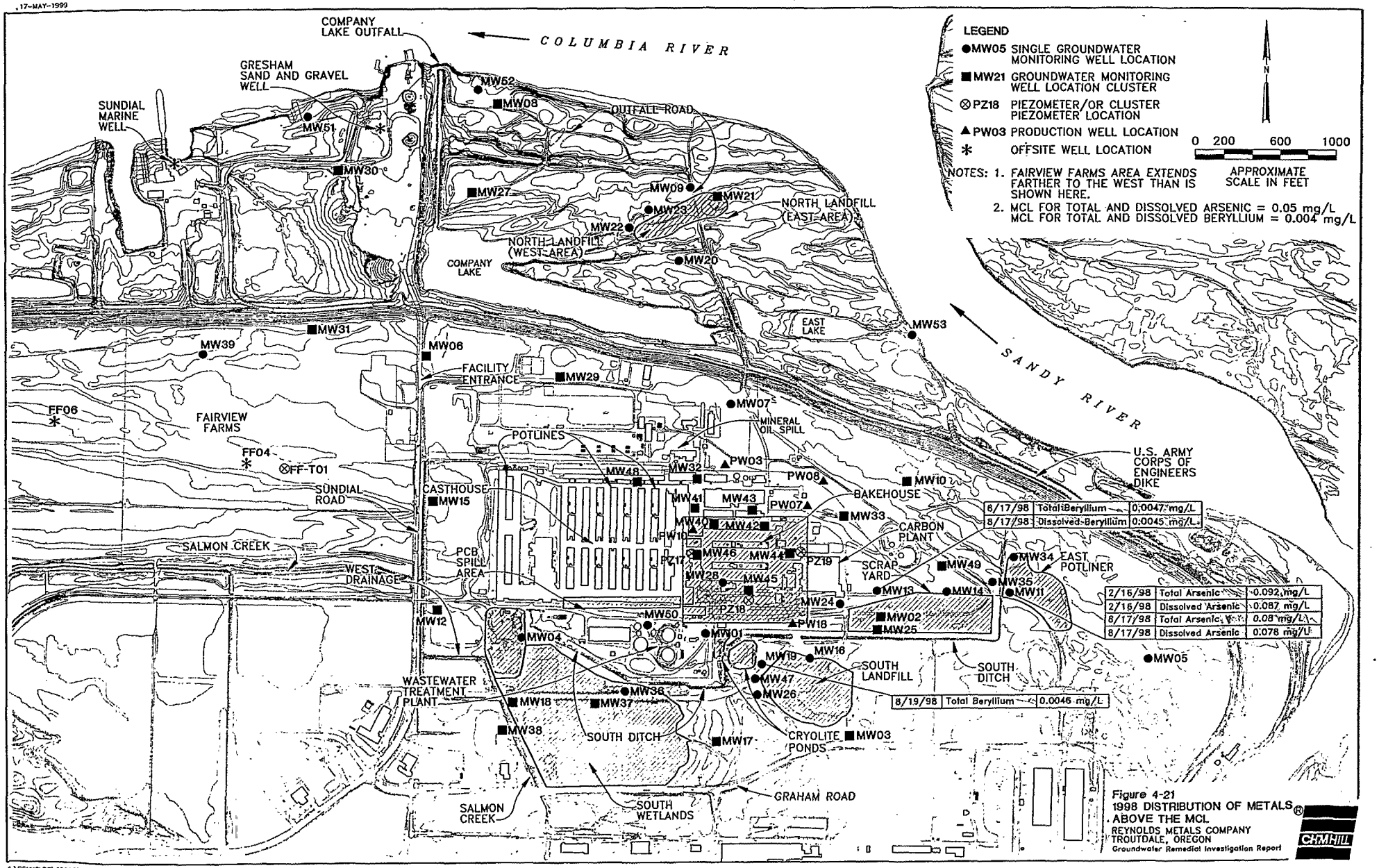

Figure 4-21
1998 DISTRIBUTION OF METALS ABOVE THE MCL
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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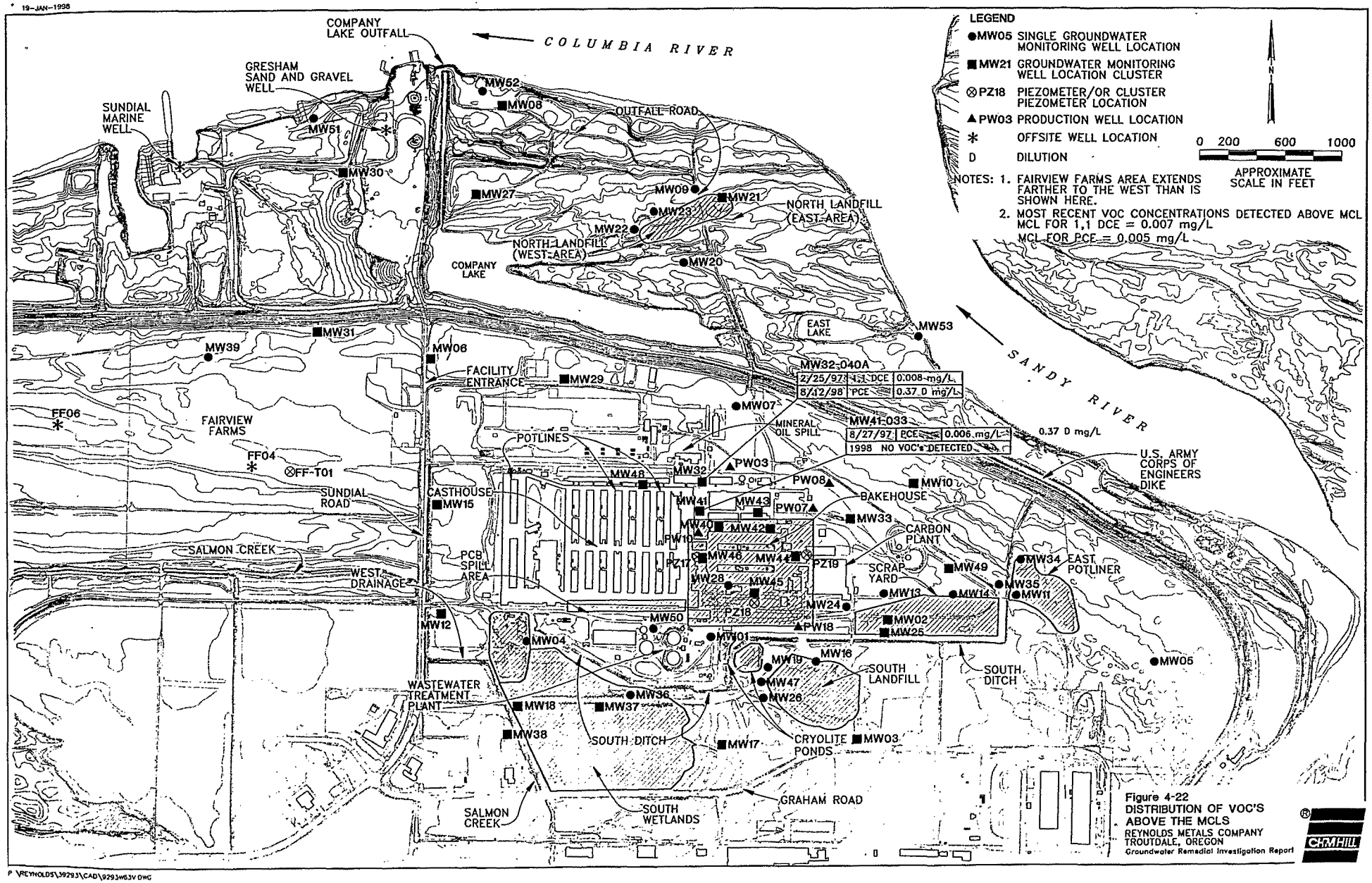

Figure 4-22
DISTRIBUTION OF VOC'S ABOVE THE MCLS
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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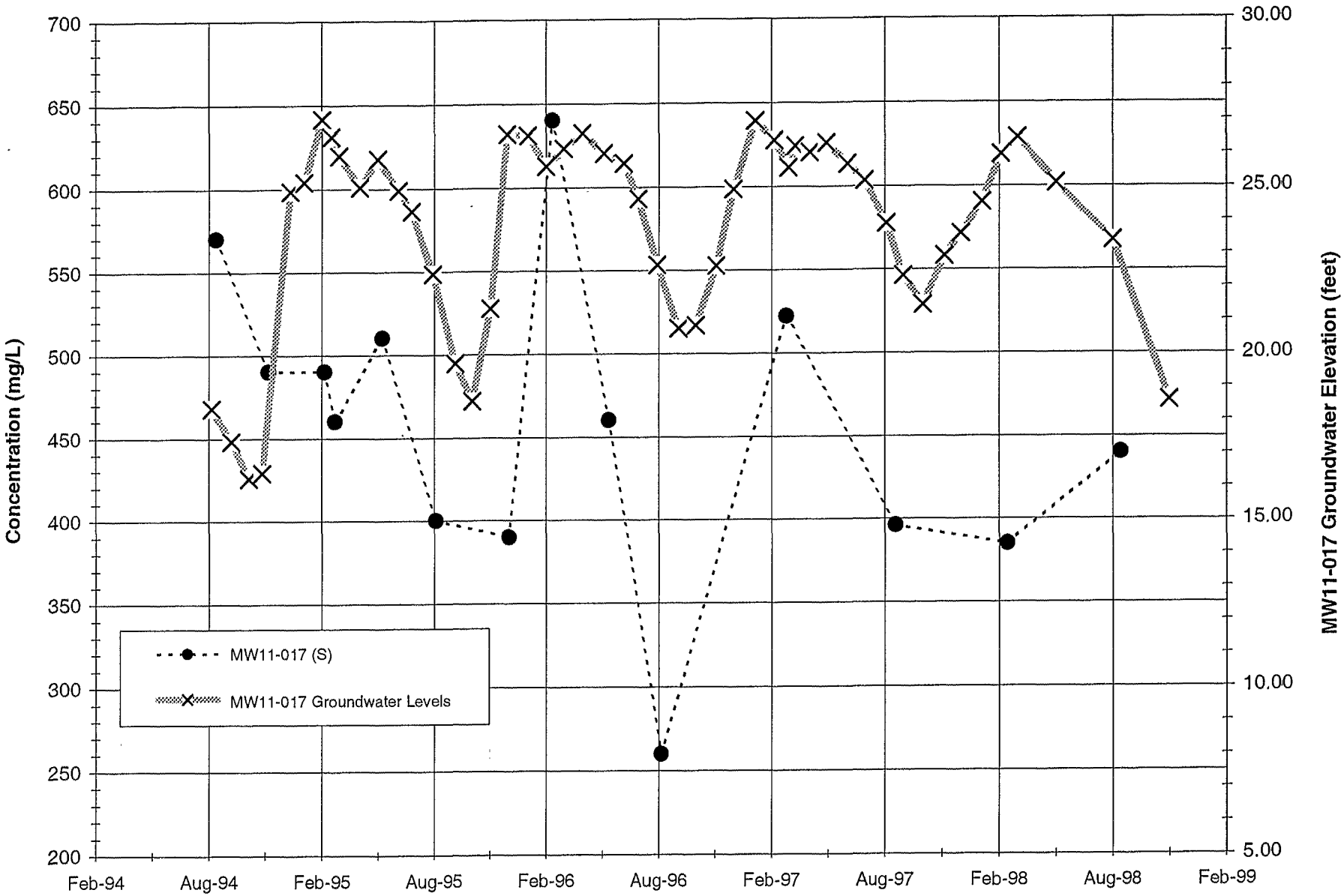

Figure 4-23
FLUORIDE TRENDS IN SILT--EAST POTLINER
REYNOLDS METALS COMPANY - TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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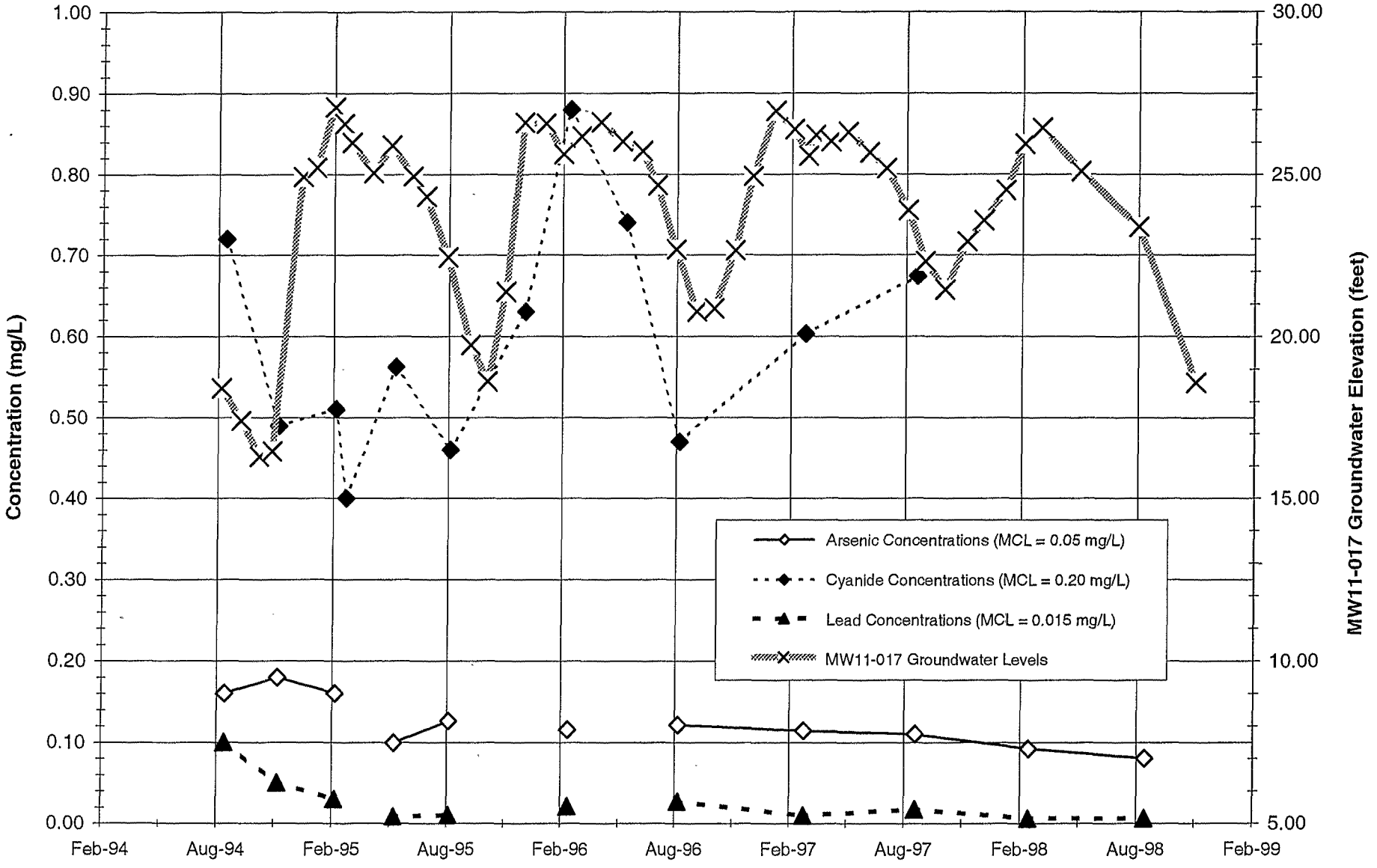

Figure 4-24
ARSENIC, CYANIDE, AND LEAD TRENDS IN SILT AT MW11-017--EAST POTLINER
REYNOLDS METALS COMPANY - TROUTDALE, OREGON
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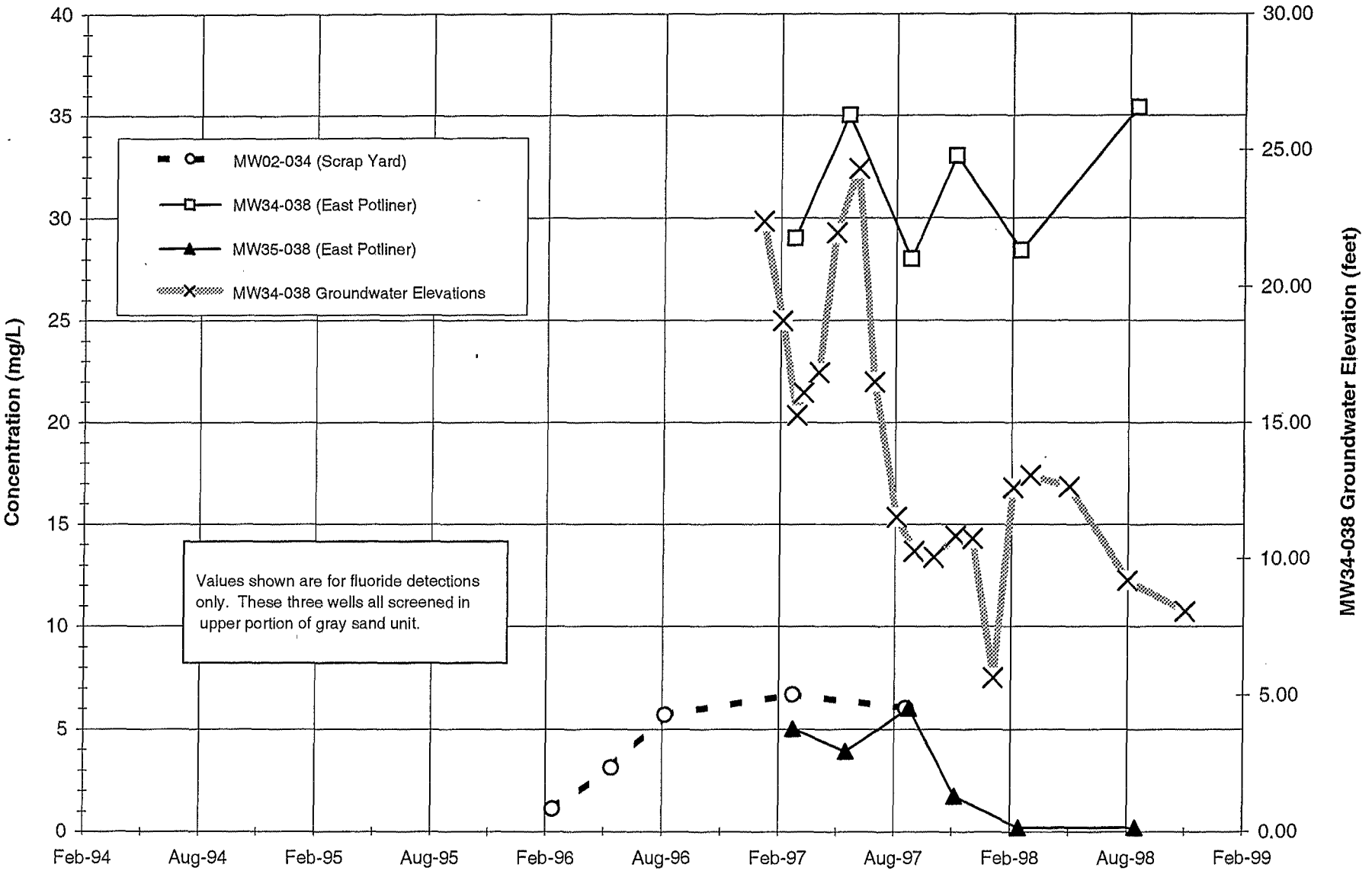

Figure 4-25
FLUORIDE TRENDS IN UGS--EAST POTLINER
REYNOLDS METALS COMPANY - TROUTDALE, OREGON
Groundwater Remedial Investigation Report

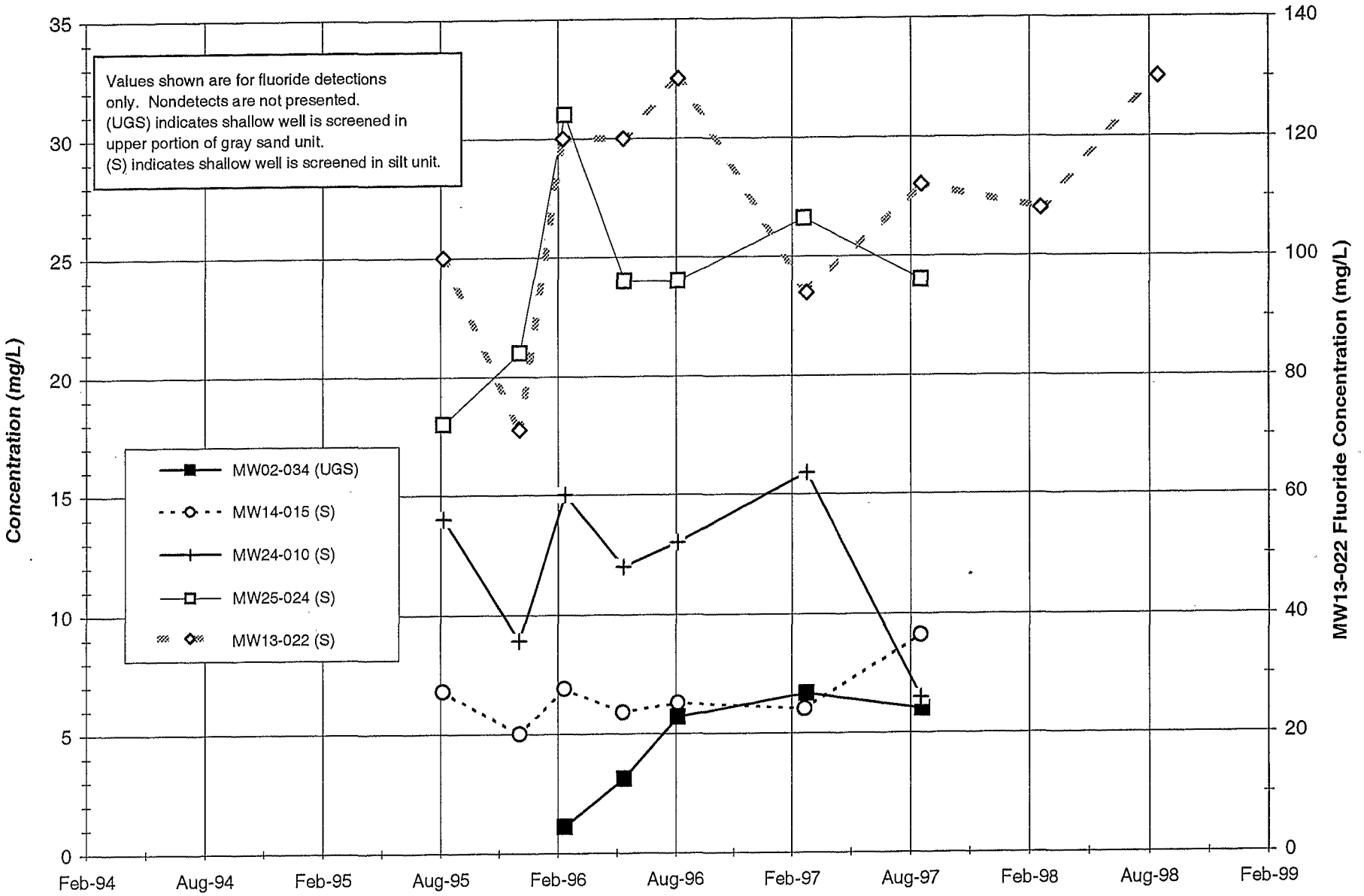

Figure 4-26
FLUORIDE TRENDS IN SILT--SCRAP YARD
REYNOLDS METALS COMPANY - TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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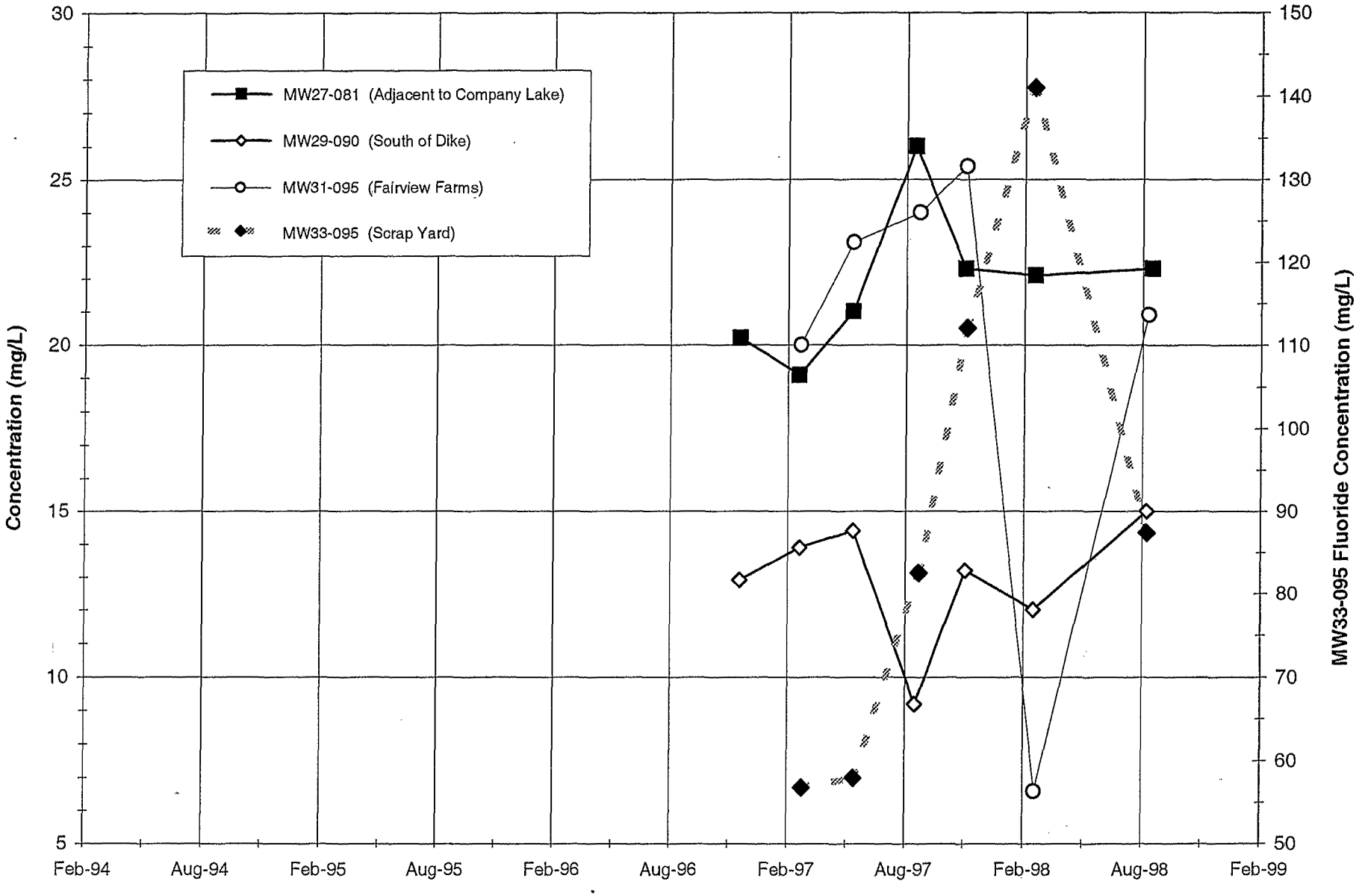

Figure 4-27

FLUORIDE TRENDS IN INTERMEDIATE-DEPTH SAND

REYNOLDS METALS COMPANY - TROUTDALE, OREGON

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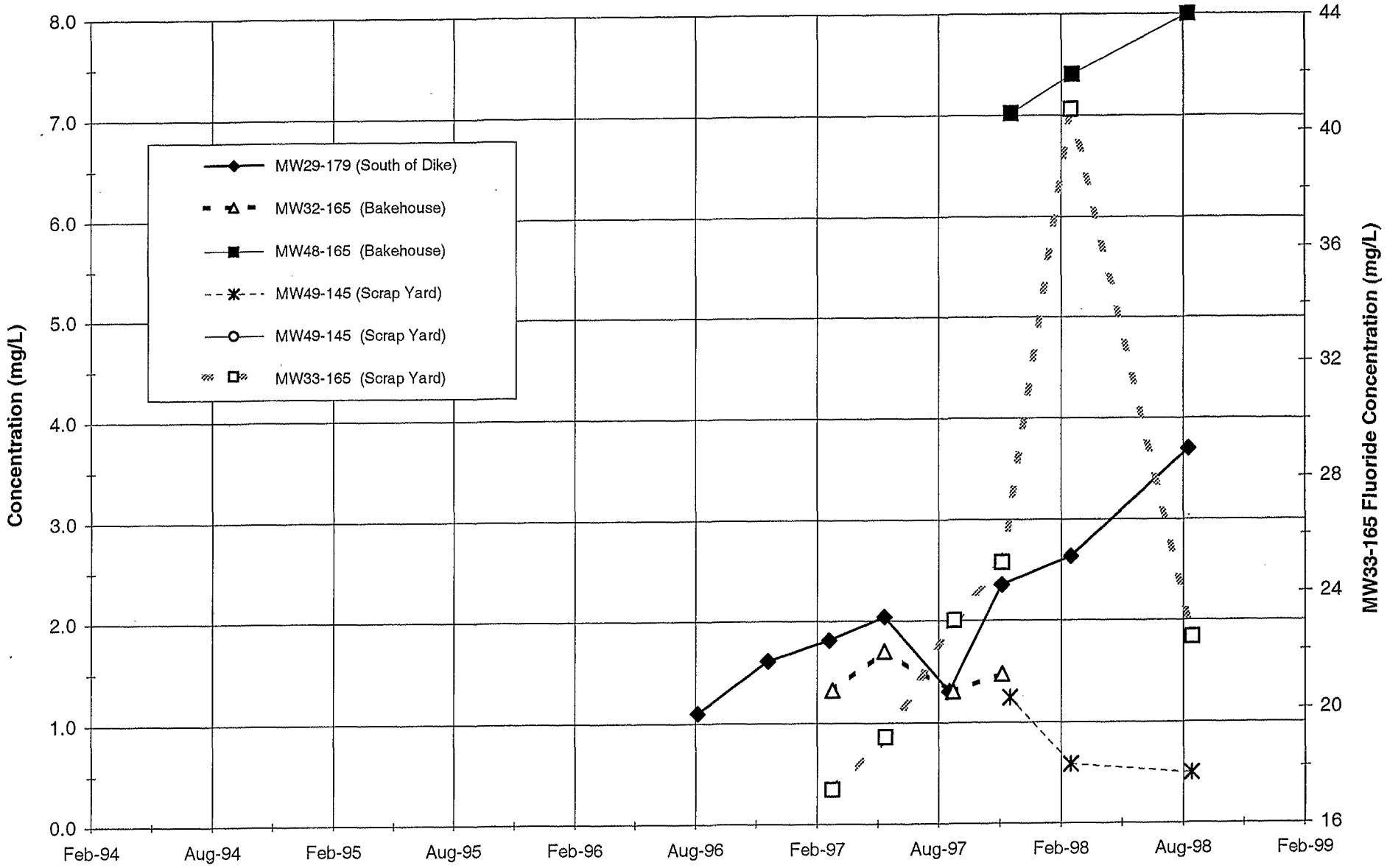

Figure 4-28
FLUORIDE TRENDS IN DEEP SAND/GRAVEL
REYNOLDS METALS COMPANY - TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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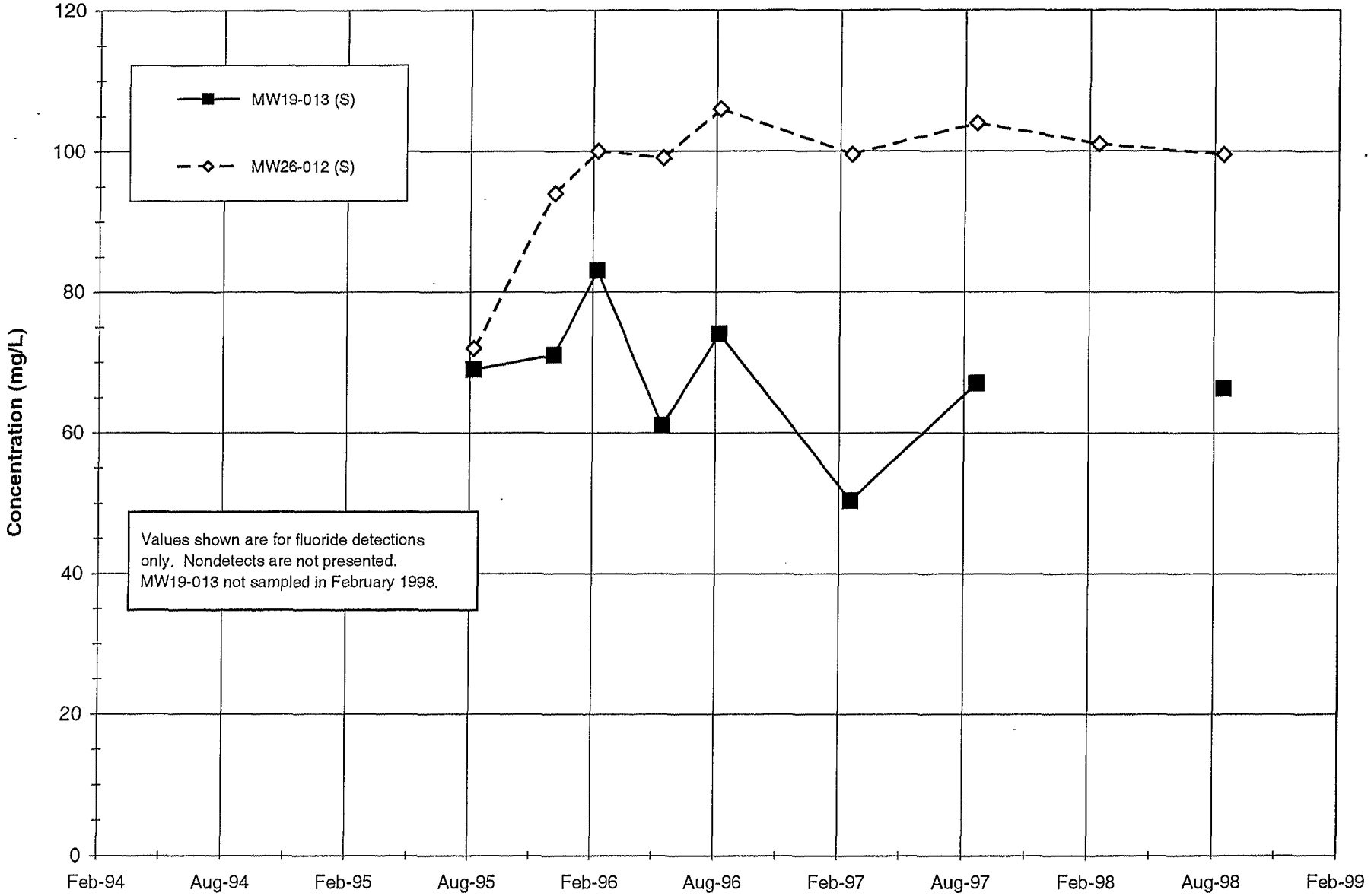

Figure 4-29

FLUORIDE TRENDS IN SILT--SOUTH LANDFILL

REYNOLDS METALS COMPANY - TROUTDALE, OREGON

Groundwater Remedial Investigation Report

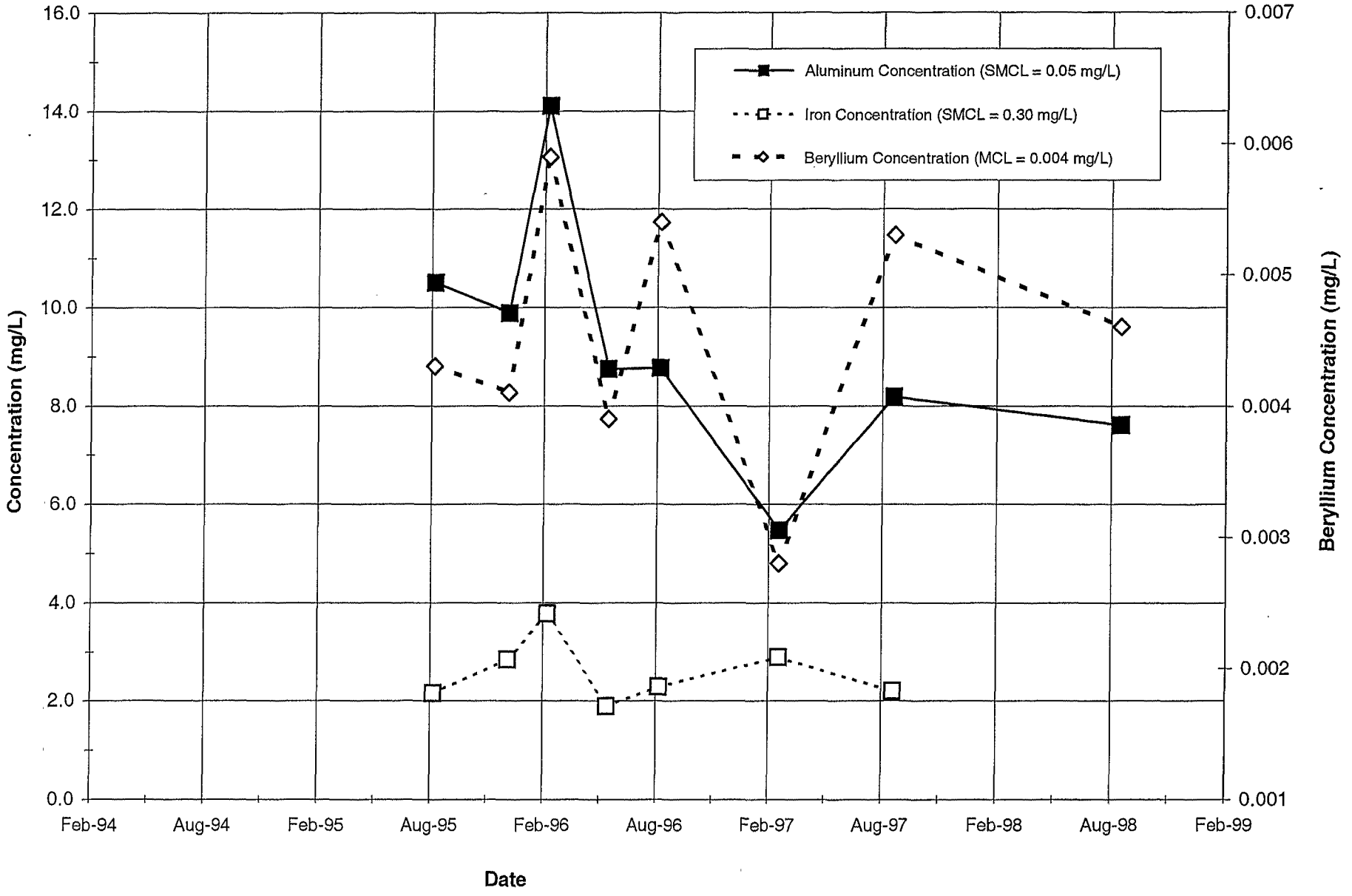

Figure 4-30
METALS TRENDS IN SILT AT MW19-013--SOUTH LANDFILL
REYNOLDS METALS COMPANY - TROUTDALE, OREGON
Groundwater Remedial Investigation Report

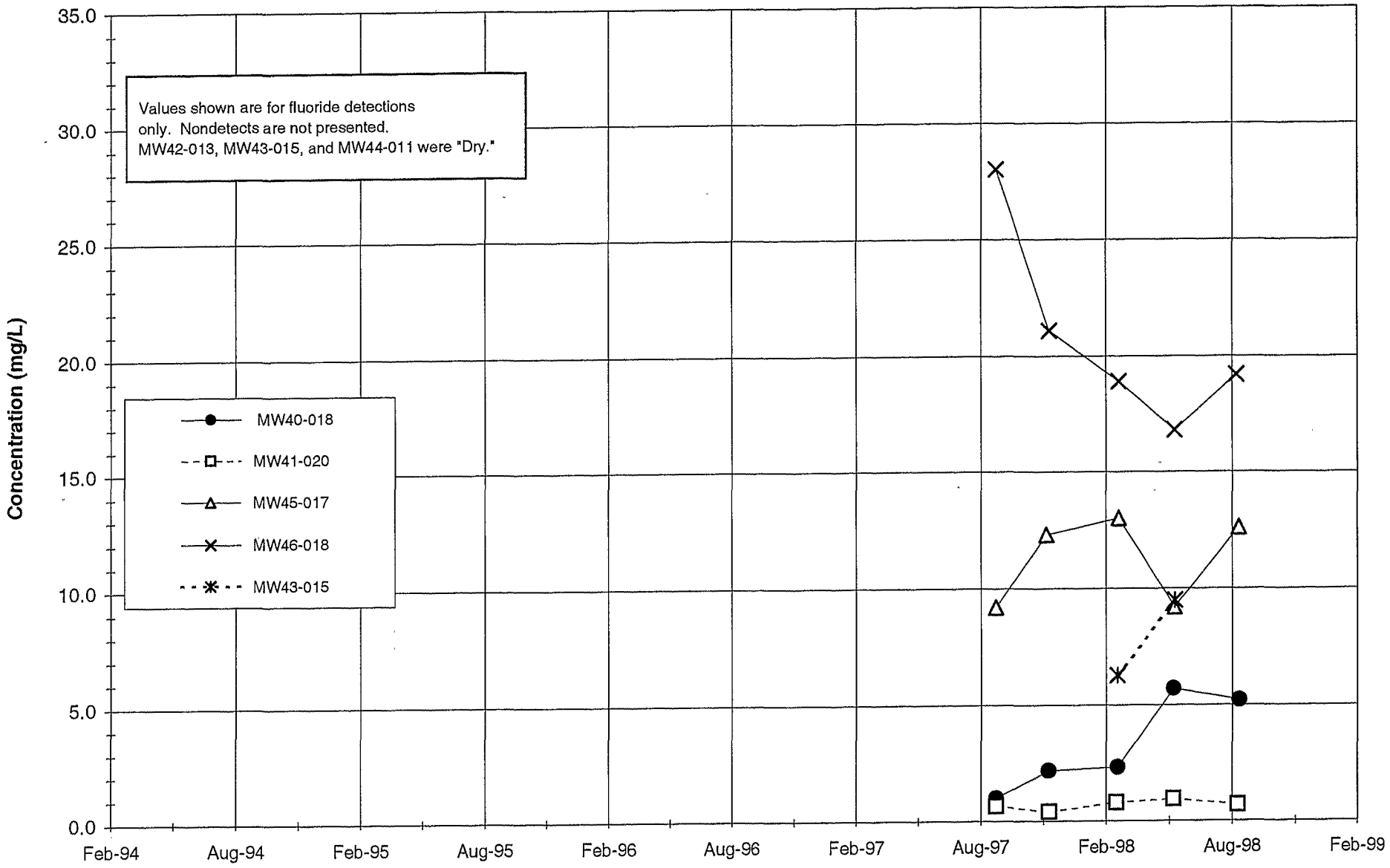

Figure 4-31
FLUORIDE TRENDS IN SILT--BAKEHOUSE
REYNOLDS METALS COMPANY - TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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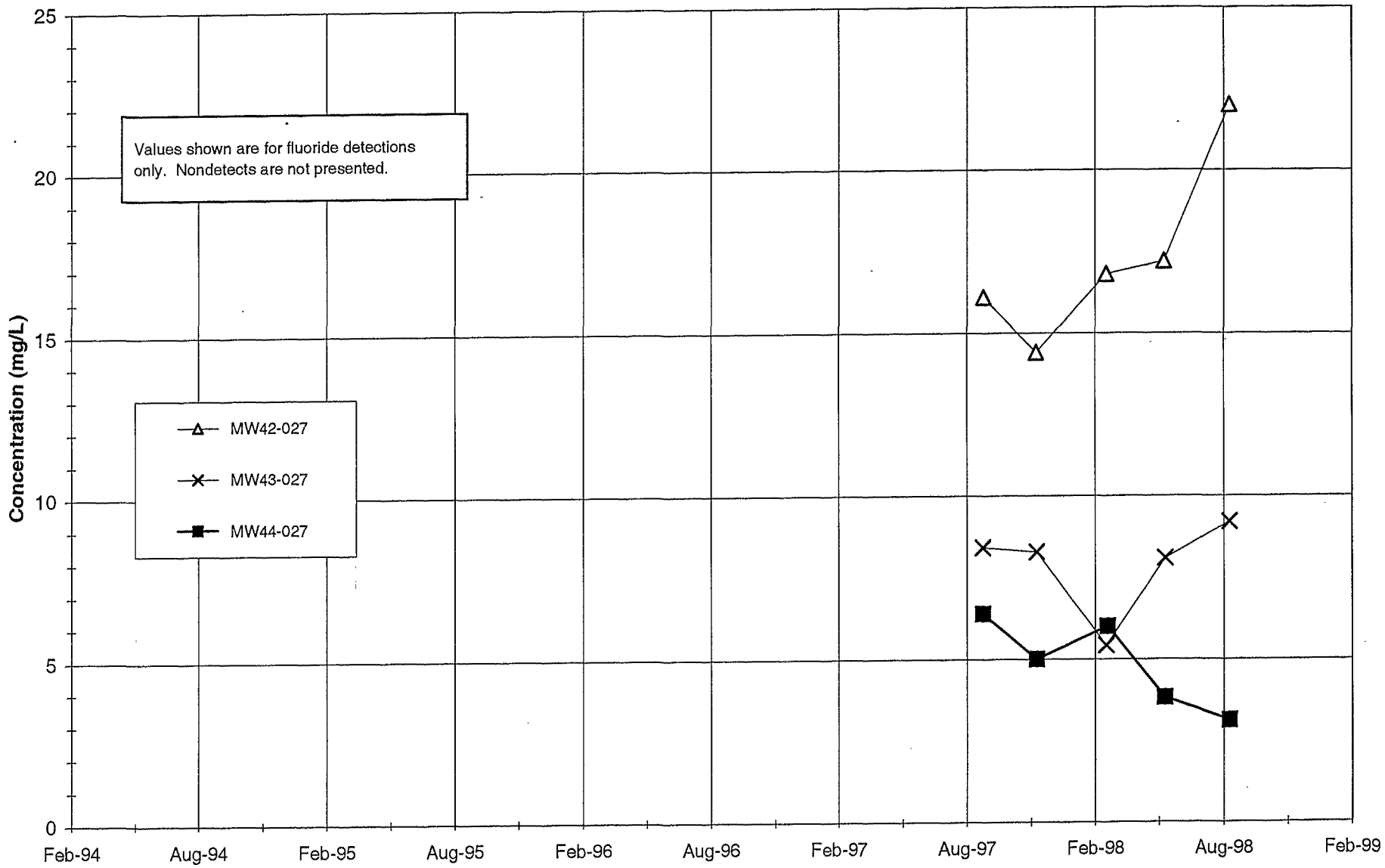

Figure 4-32
FLUORIDE TRENDS IN UGS--BAKEHOUSE
REYNOLDS METALS COMPANY - TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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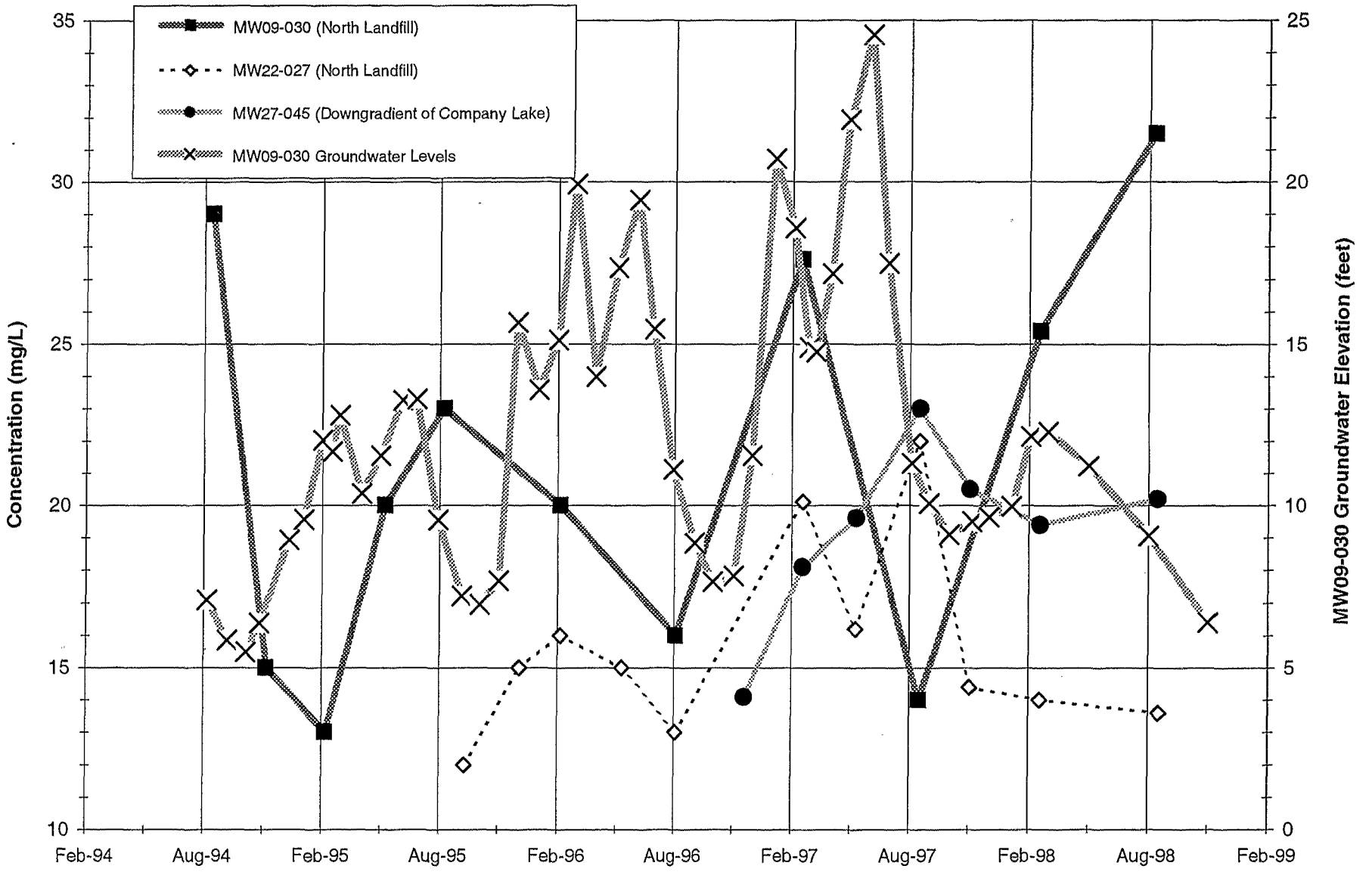


Figure 4-33
FLUORIDE TRENDS IN UGS--NORTH LANDFILL AND COMPANY LAKE
REYNOLDS METALS COMPANY - TROUTDALE, OREGON
Groundwater Investigation Report

SECTION 5

Fluoride Migration in Groundwater

Color Codes for Figure 5-1 through Figure 5-8

Areas Where Fluoride Concentrations Currently Exceed MCLs:

Upper Gray Sand (UGS)

Intermediate and Deep Zones

Particle Traces

Yellow — Silt Unit (Layer 1 of groundwater flow model)

Silt Unit (Layer 2 of groundwater flow model)

Upper Gray Sand (UGS) (Layer 3 of groundwater flow model)

Intermediate Zone (Layer 4 of groundwater flow model)

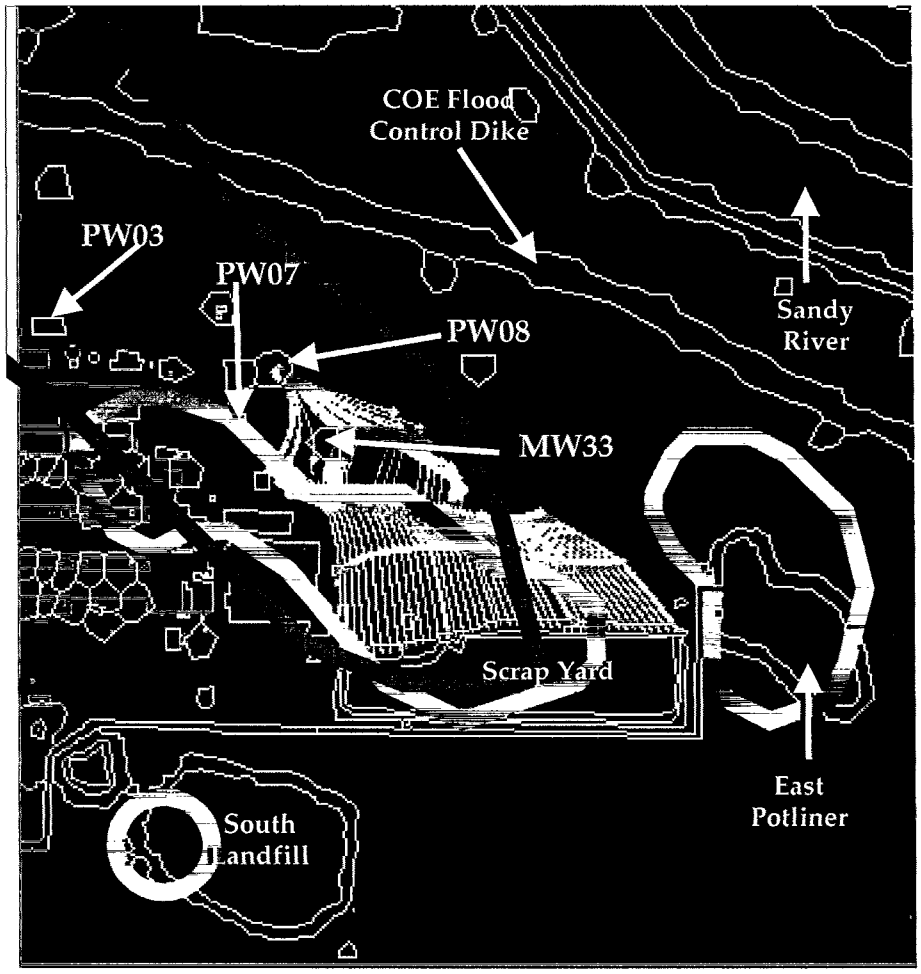
White — Intermediate Zone (Layer 5 of groundwater flow model)

Dark Blue — Deep Zone (Layer 6 of groundwater flow model)

Dark Green — Deep Zone (Layer 7 of groundwater flow model)

Deep Zone (Layer 8 of groundwater flow model)

Yellow — Deep Zone (Layer 9 of groundwater flow model)



This figure shows imaginary particles that are initiated in the groundwater flow model and traced forward in time. The particles are placed at the top of the upper gray sand (UGS) along the northern boundary of the scrap yard soil and debris area. The figure shows particles moving from the UGS (green) into the intermediate zone (magenta and white), then into the deep zone (dark blue and dark green), where they are captured by production well PW08. Site features are outlined in white, and plant buildings are shown in red. The figure also shows the thick blue and red lines that outline areas where fluoride concentrations currently exceed the MCL (4 mg/L) in the UGS and intermediate zones, respectively.

Figure 5-1
Groundwater Migration from the UGS at Scrap Yard Under
Long-Term Average Pumping Rates from RMC Production Wells
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

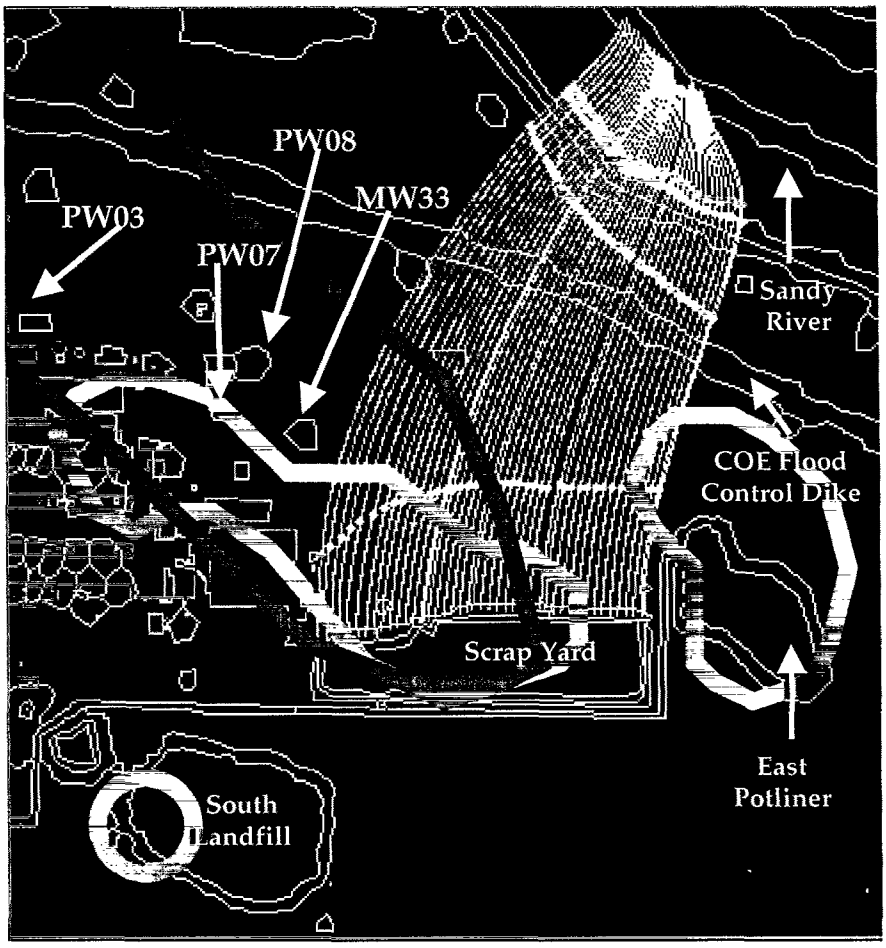
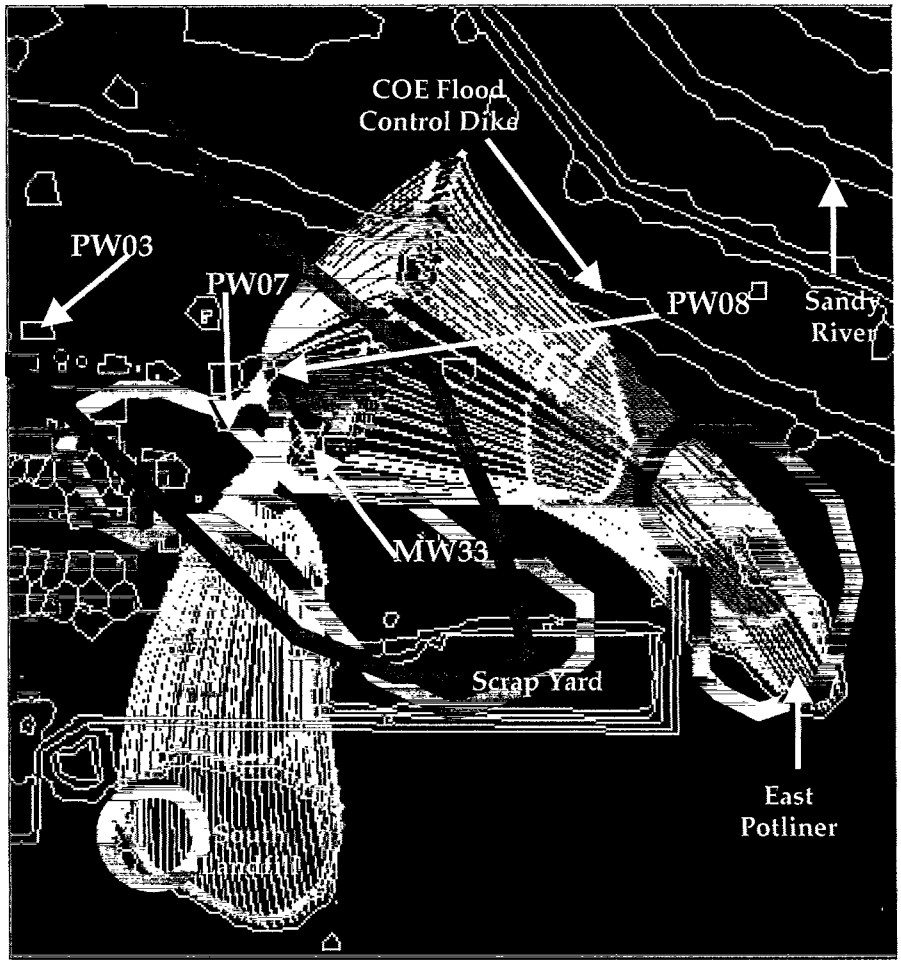


Figure 5-2 is similar to Figure 5-1, except the RMC production wells are not pumping. The figure shows particles moving from the UGS (light green) into the intermediate zone (magenta) south of the COE flood control dike, then rising back into the UGS (green) before discharging into the Sandy River (cyan and yellow traces). The figure also shows the thick blue and red lines that outline areas where fluoride concentrations currently exceed the MCL (4 mg/L) in the UGS and intermediate zones, respectively.

Figure 5-2
Groundwater Migration from the UGS at Scrap Yard Under Hypothetical No-Pumping Scenario for RMC Production Wells
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report



This figure is similar to Figure 5-1, except the particles are initiated along the perimeter of the south landfill and east potliner soil and debris areas. The particles are placed at the top of the upper gray sand (UGS) as in Figure 5-1. The figure shows particles moving from the UGS (green) into the intermediate zone (magenta and white), then into the deep zone (dark blue, dark green, red, and yellow), where they are captured by production wells PW07 and PW08. The figure also shows the thick blue and red lines that outline areas where fluoride concentrations currently exceed the MCL (4 mg/L) in the UGS and intermediate zones, respectively.

Figure 5-3
Groundwater Migration from the UGS at South Landfill and East Potliner Under Long-Term Average Pumping Rates from RMC Production Wells
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

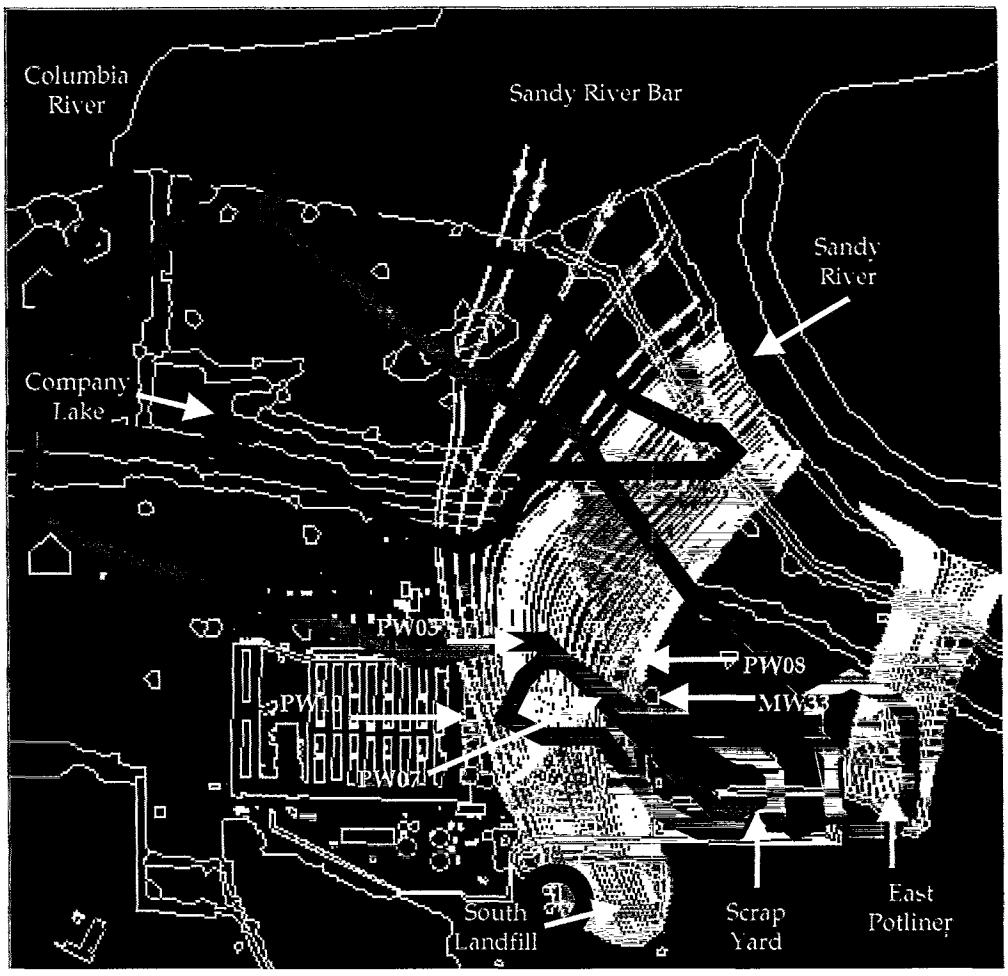


Figure 5-4 is similar to Figure 5-3, except the RMC production wells are not pumping and the figure shows a larger portion of the site. The figure shows particles moving from the UGS (light green) into the intermediate zone (magenta and white) on the plant site. The particles that are initiated at east potliner then rise back into the UGS (green) before discharging into the Sandy River (cyan and yellow traces). Particles initiated at south landfill travel in the intermediate zone beneath the plant site, then rise back into the UGS along the bank of the Sandy River. The figure also shows the thick blue and red lines that outline areas where fluoride concentrations currently exceed the MCL (4 mg/L) in the UGS and intermediate zones, respectively.

Figure 5-4
Groundwater Migration from the UGS at South Landfill and East Potliner Under Hypothetical No-Pumping Scenario for RMC Production Wells
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

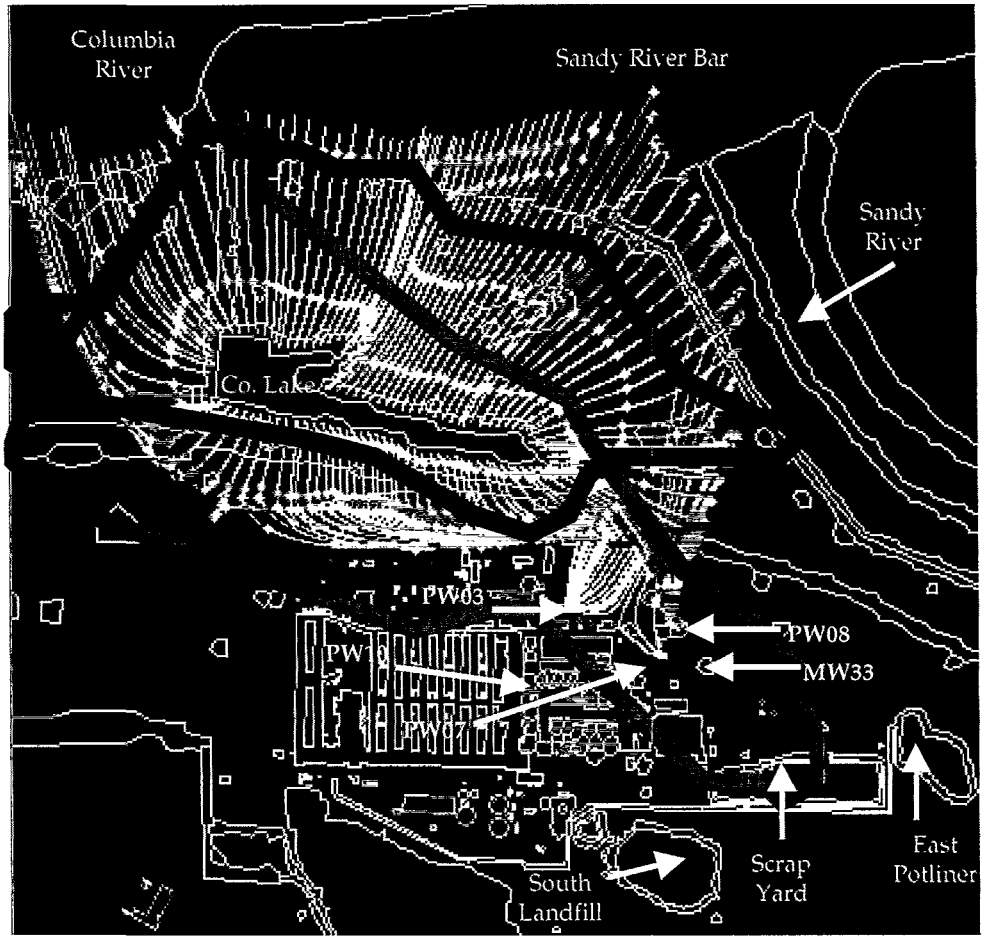


Figure 5-5 shows particles initiated along the perimeter of Company Lake. The particles are initiated in the model at elevations corresponding to the elevation of process residue on the bed of the lake. The figure also shows a thick blue line outlining the area where fluoride concentrations around Company Lake currently exceed 4 mg/L in the UGS. The figure shows particles moving from the UGS (light blue and green) into the intermediate zone (magenta and white), then into the deep zone (dark blue, dark green, red, and yellow), where they are captured by production wells PW03, PW07 and PW08. Some particles moving towards the Sandy River migrate into the deep zone (dark blue and dark green), then migrate to the southwesterly direction and are captured by the production wells.

Figure 5-5
Groundwater Migration from Company Lake Under
Long-Term Average Pumping Rates from RMC Production Wells
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

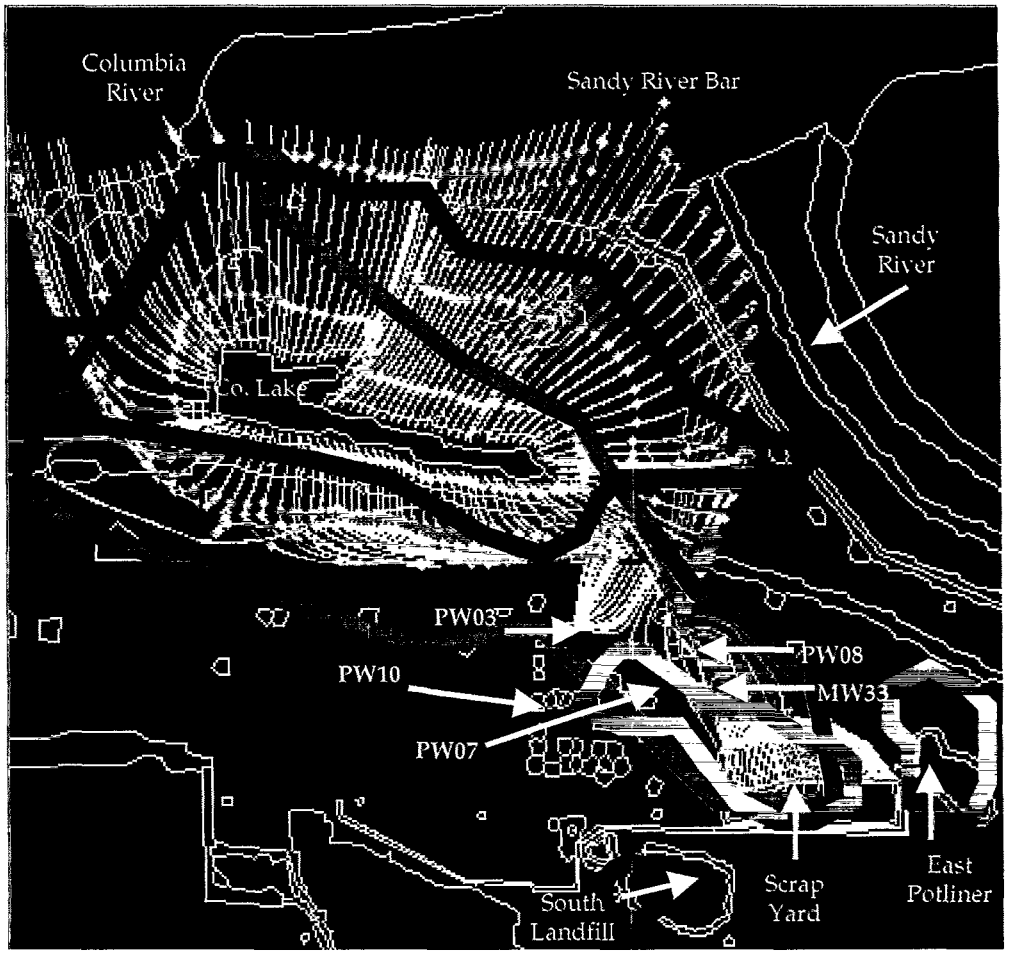


Figure 5-6 shows the combined particle traces from Figures 5-1 and 5-5. The figure also shows the thick blue and red lines that outline areas where fluoride concentrations currently exceed the MCL (4 mg/L) in the UGS and intermediate zones, respectively. The figure shows how the traces of particles initiated at scrap yard and the southern perimeter of Company Lake coincide with the presence of fluoride above the MCL.

Figure 5-6
Comparison of Intermediate Zone Fluoride Plume with Groundwater Flowpaths from Scrap Yard and Company Lake
Under Long-Term Average Pumping Rates from RMC Production Wells
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

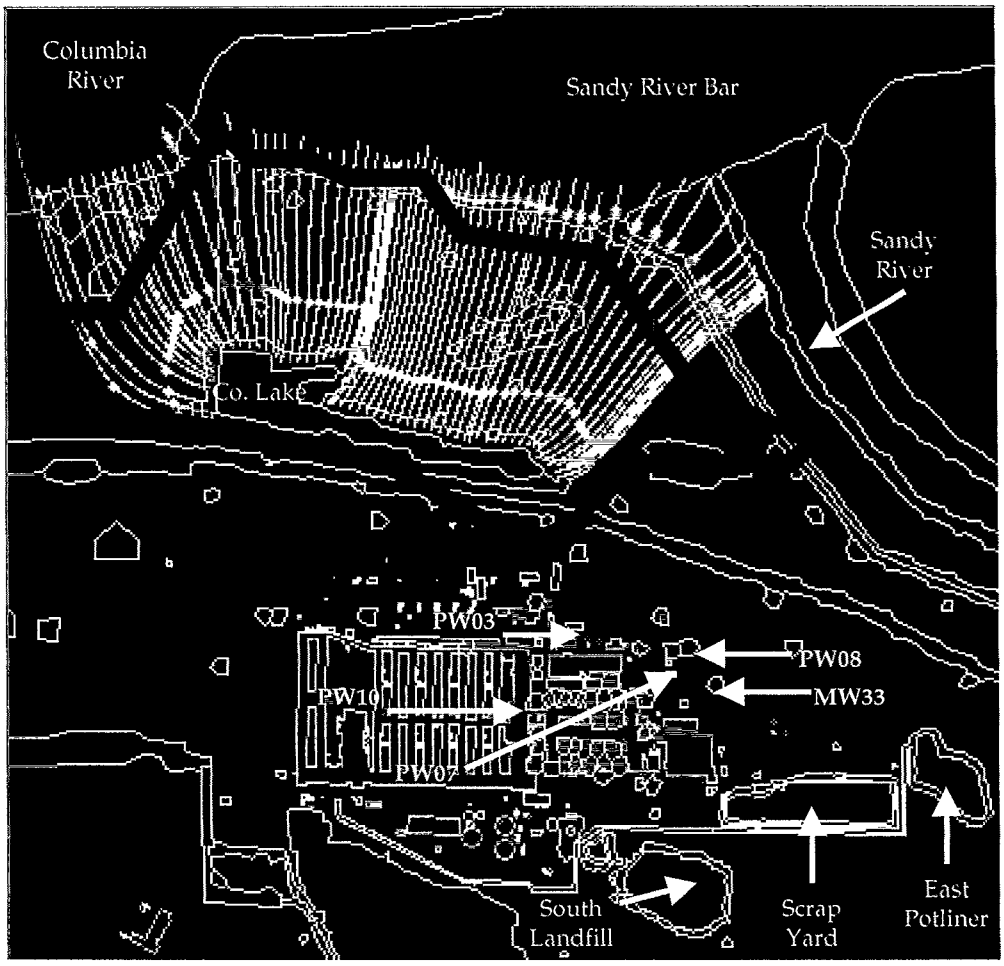


Figure 5-7 is similar to Figure 5-5, except the RMC production wells are not pumping and the figure shows a larger portion of the site. Also, particles are initiated only along the northern and western perimeters of the lake for clarity purposes. The figure shows particles migrating away from the lake and discharging into the Columbia River, the Sandy River, and the Sandy River bar. Most particles remain within the UGS (light blue and green). The thick blue line outlines the area around Company Lake where fluoride concentrations in UGS groundwater currently exceed the MCL (4 mg/L).

Figure 5-7
Groundwater Migration from the Northern and Western Perimeter of Company Lake Under Hypothetical No-Pumping Scenario for RMC Production Wells
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

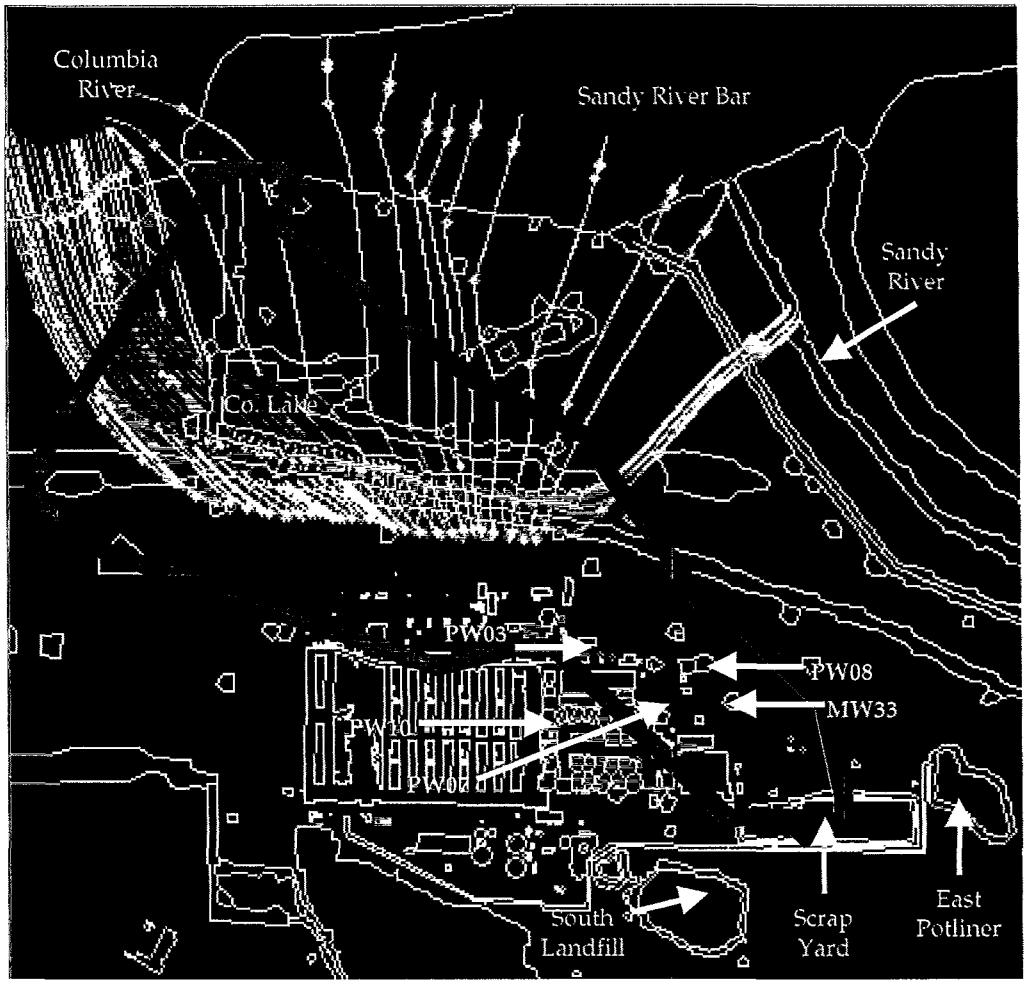
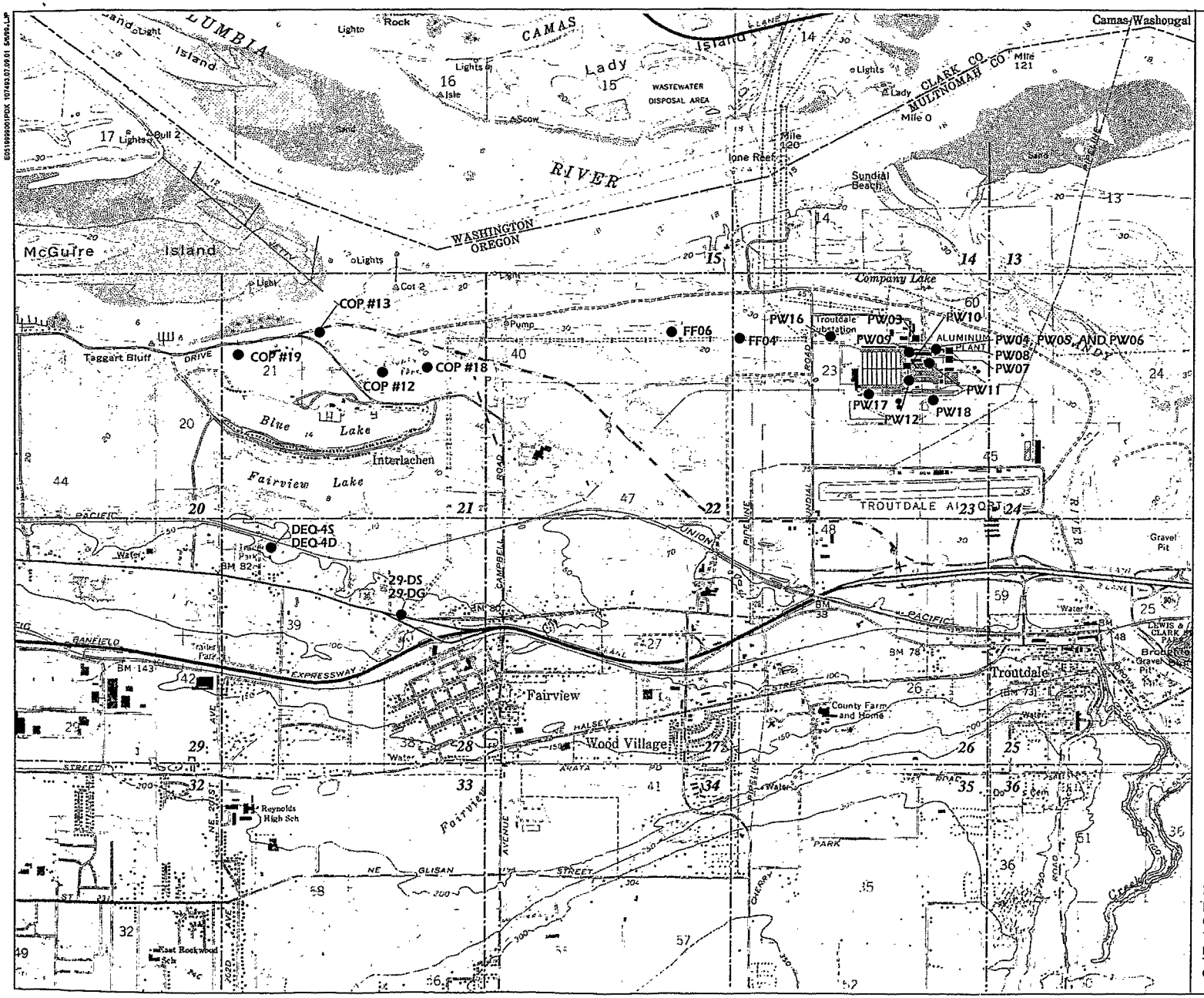


Figure 5-8 is similar to Figure 5-7, except particles are initiated along the southern perimeter of Company Lake. The figure shows that particles migrate only short distances in the UGS (light blue and green) before moving into the intermediate zone (magenta and white). Some particles due south of the lake also move into the deep zone (dark blue). Particles move primarily towards the Columbia River, with movement also towards the Sandy River and its bar. The thick red line is the area where fluoride concentrations in intermediate zone groundwater currently exceed the MCL (4 mg/L).

Figure 5-8
Groundwater Migration from the Southern Perimeter of Company Lake Under Hypothetical No-Pumping Scenario for RMC Production Wells
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report



LEGEND

FF06 ●	Monitoring well location
■	Pumped production well location
PW	Reynolds Metals Company production well
COP	City of Portland well
FF	Fairview Farms, owned by Reynolds Metals
DEQ	Oregon Department of Environmental Quality well
29-DS 29-DG	Cascade Corporation well

Base map: U.S. Geological Survey 7.5 minute Camas, Washington Quadrangle. Photo revised 1970 and 1975. Contour interval: 10 feet.

NORTH

0 2,000 Feet

Approximate Scale

Figure 5-9
PUMPING WELLS, DEEP WELLS, AND OFFSITE WELLS MONITORED FOR THE 1995 MULTIPLE-WELL AQUIFER TEST
REYNOLDS METALS COMPANY
TROUTDALE, OREGON
Groundwater Remedial Investigation Report

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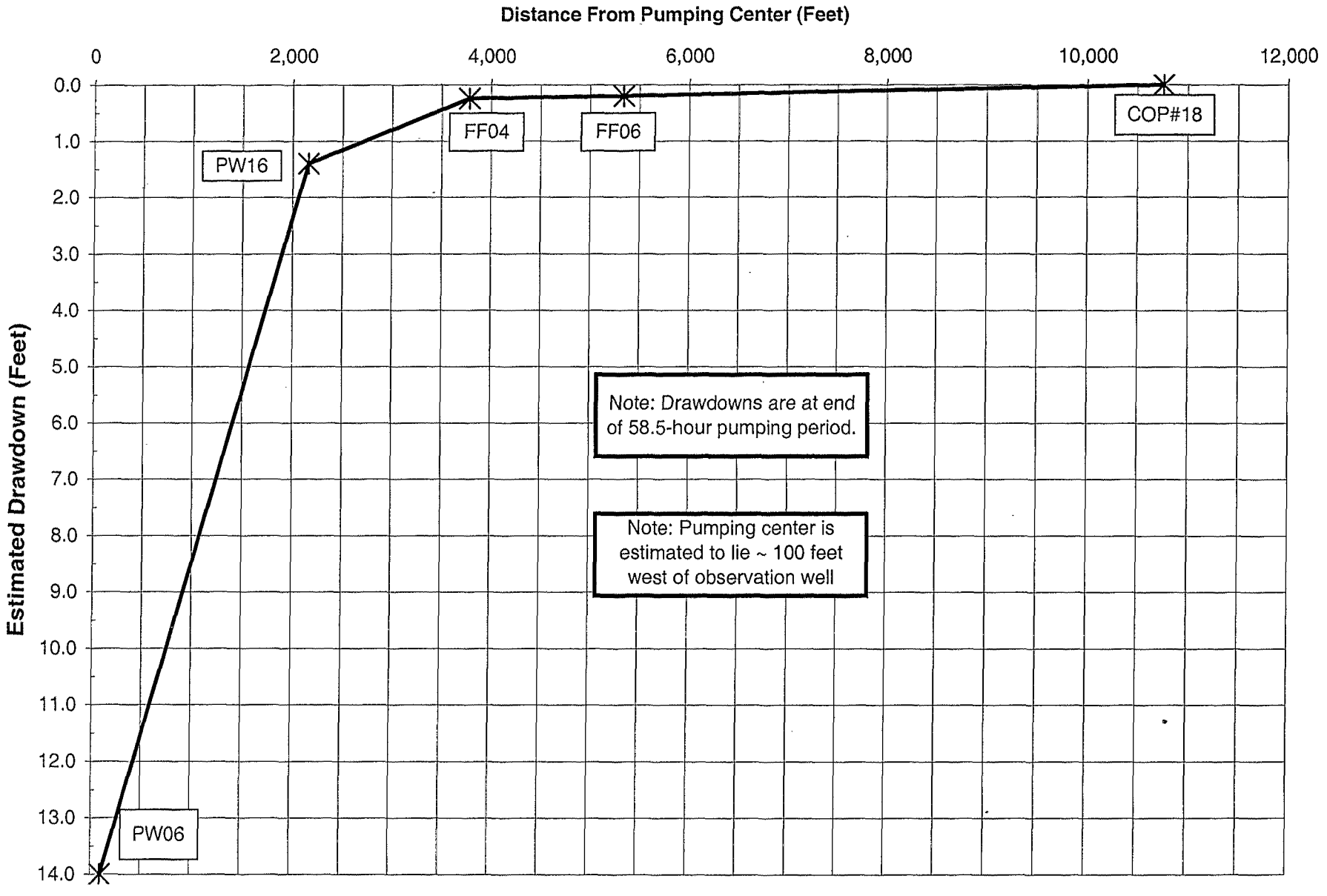

Figure 5-10
Distance-Drawdown Plot for 1995 Multiple-Well Aquifer Test
Reynolds Metals Company (Troutdale, Oregon)
Groundwater Remedial Investigation Report

Figure 5-10.xls\DISTDD

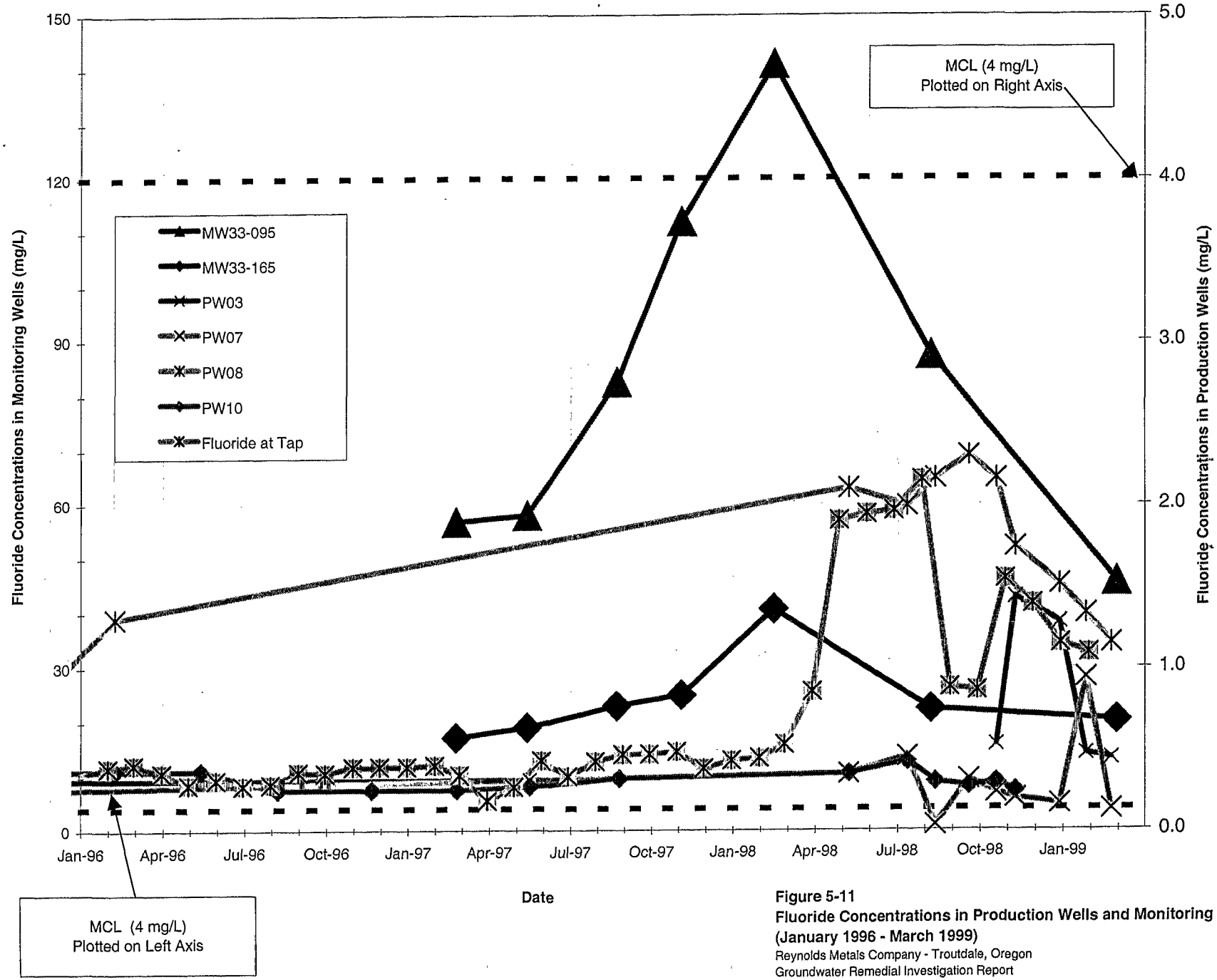

Figure 5-11
Fluoride Concentrations in Production Wells and Monitoring Wells (January 1996 - March 1999)
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

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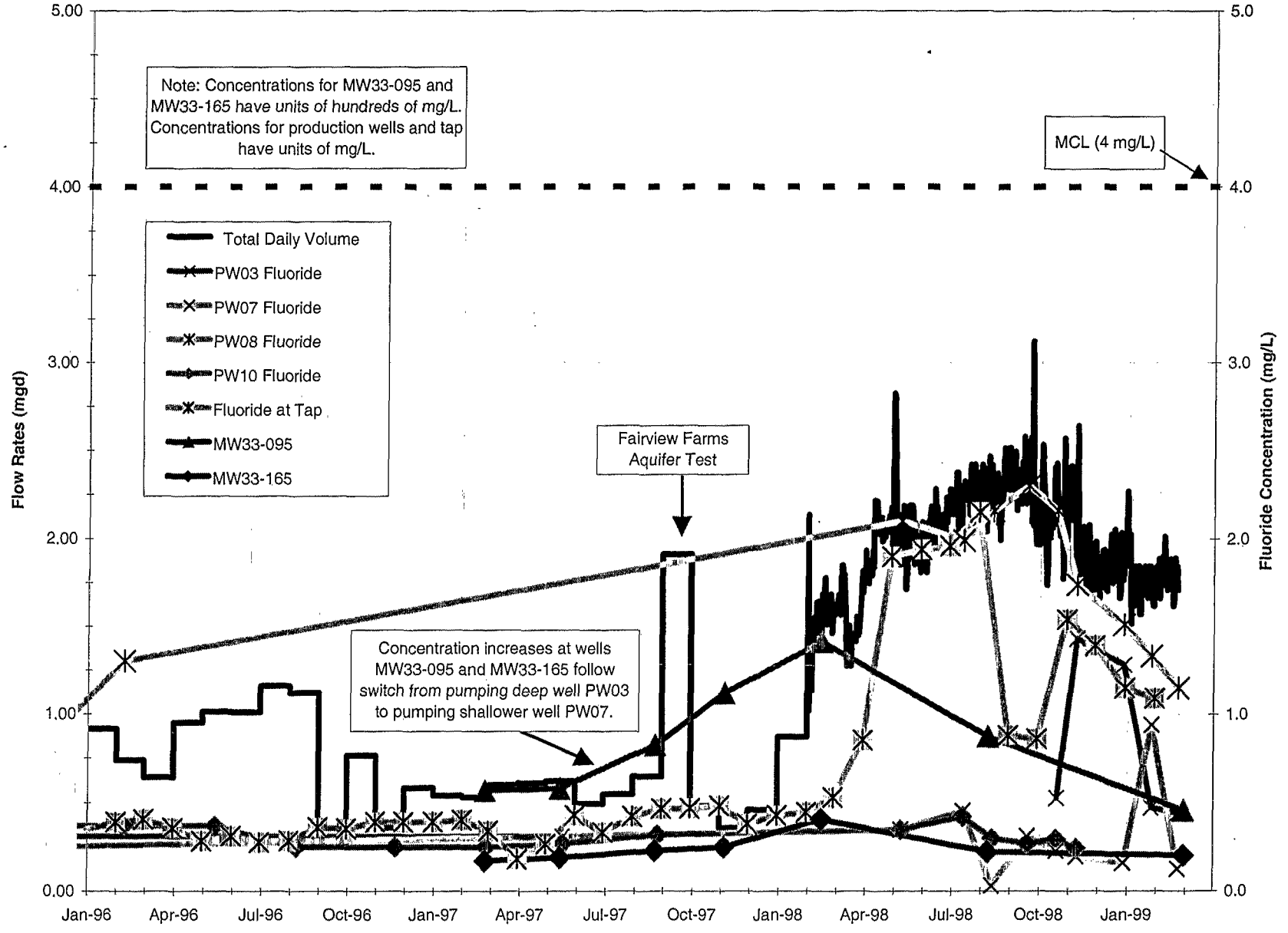

Figure 5-12
Production Well Pumping Rates and Fluoride Concentrations (January 1996 - March 1999)
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

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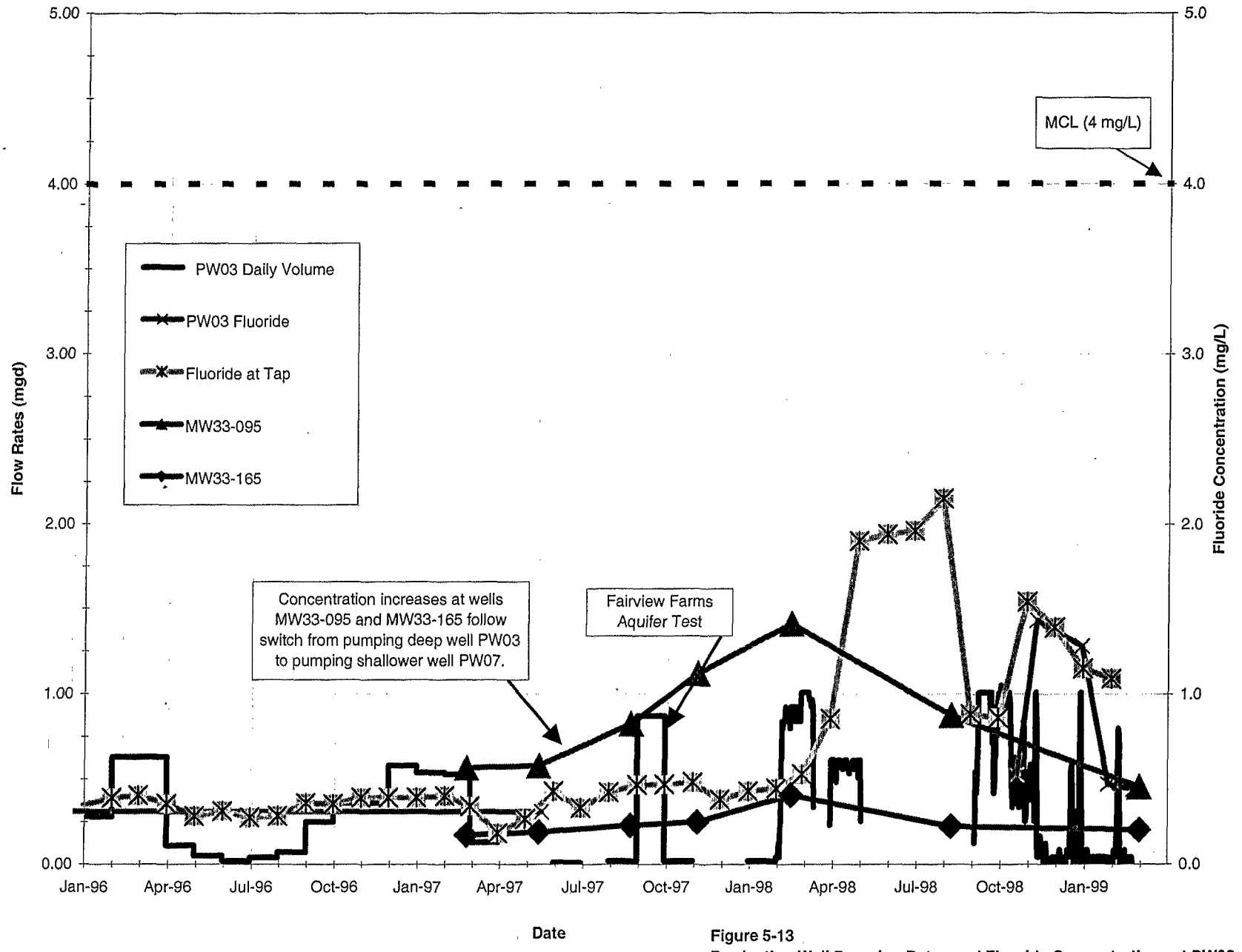

Figure 5-13
Production Well Pumping Rates and Fluoride Concentrations at PW03 (January 1996 - March 1999)
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

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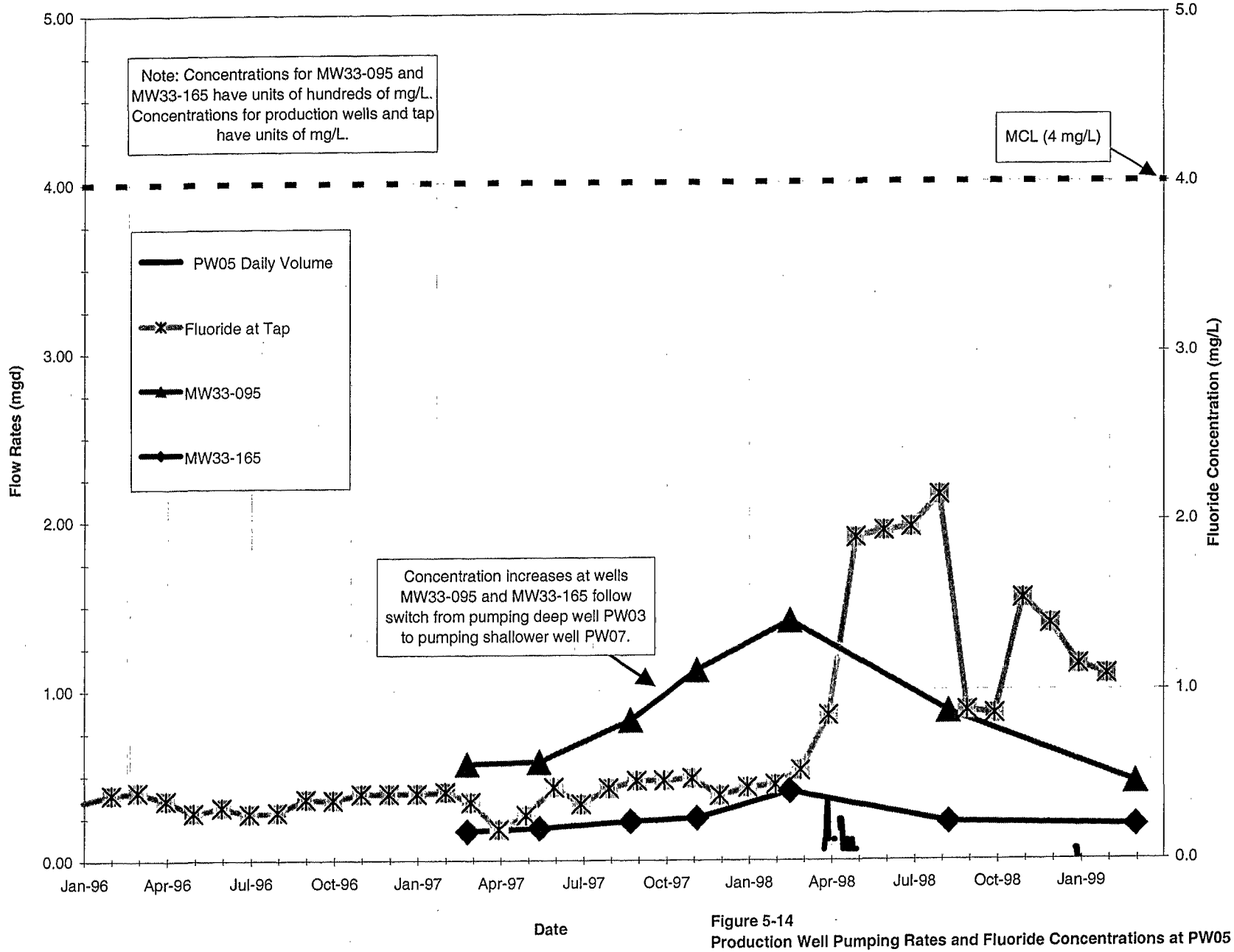

Figure 5-14
Production Well Pumping Rates and Fluoride Concentrations at PW05 (January 1996 - March 1999)
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

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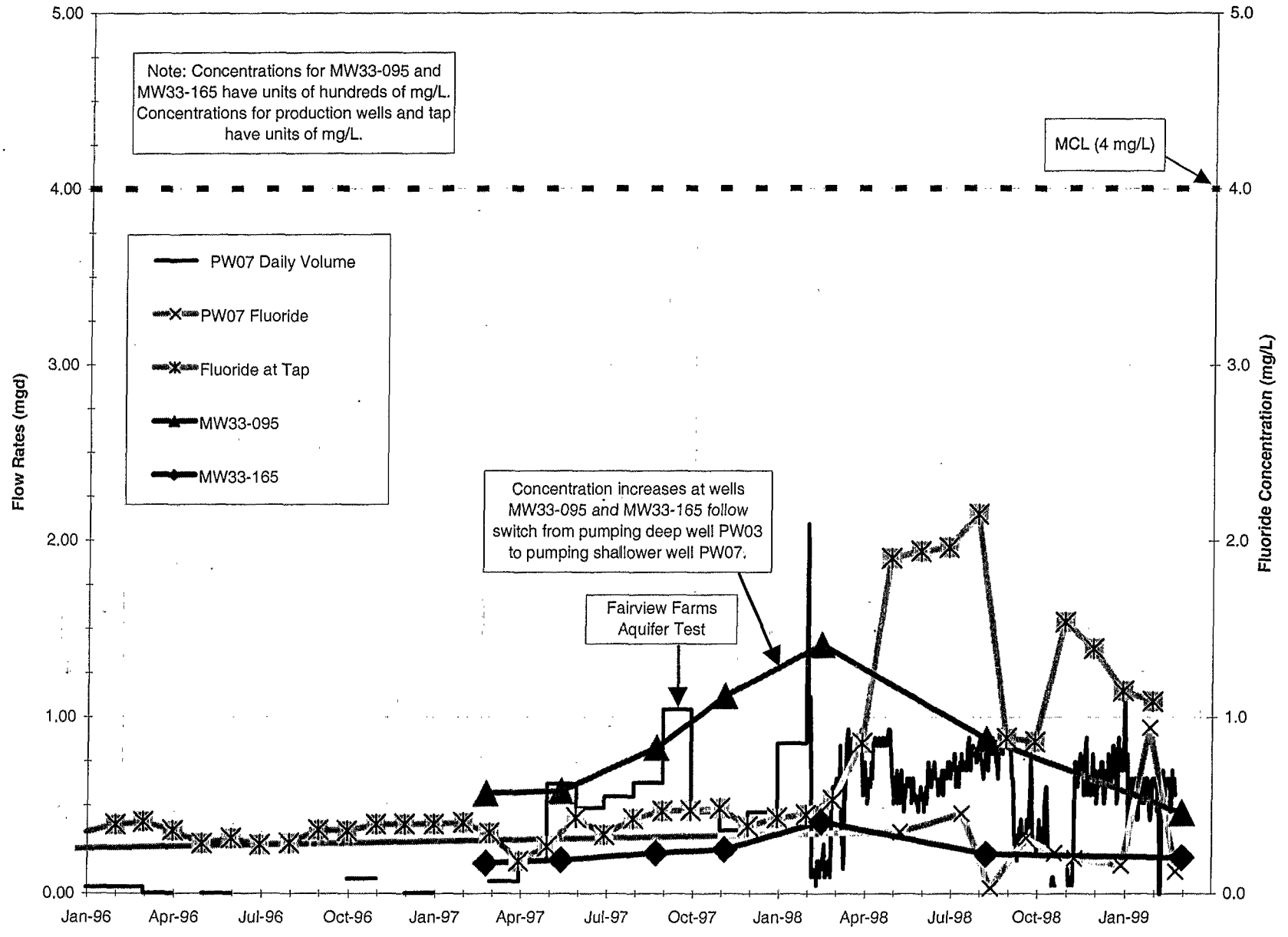

Figure 5-15
Production Well Pumping Rates and Fluoride Concentrations at PW07 (January 1996 - March 1999)
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

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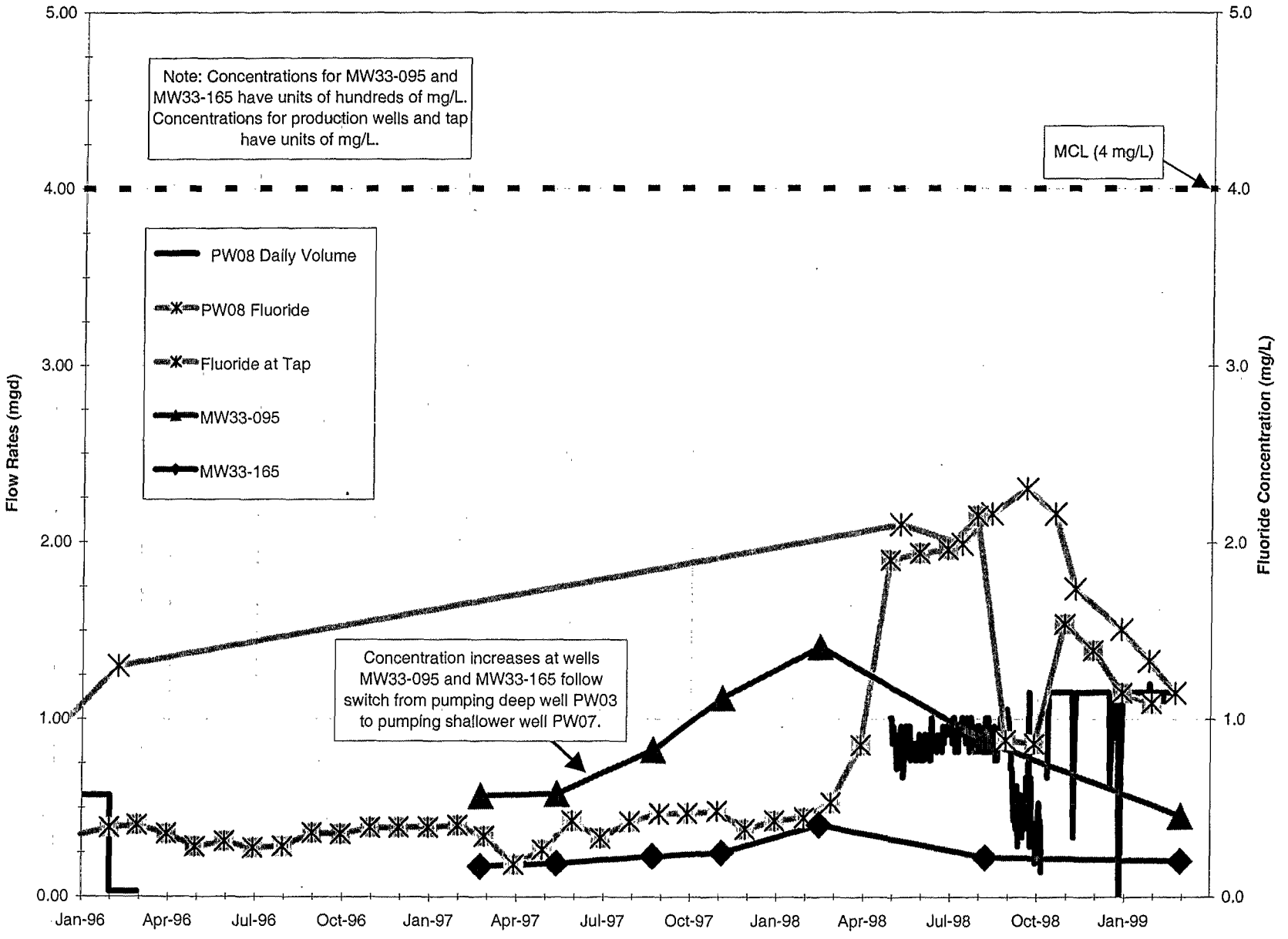

Figure 5-16
Production Well Pumping Rates and Fluoride Concentrations at PW08 (January 1996 - March 1999)
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

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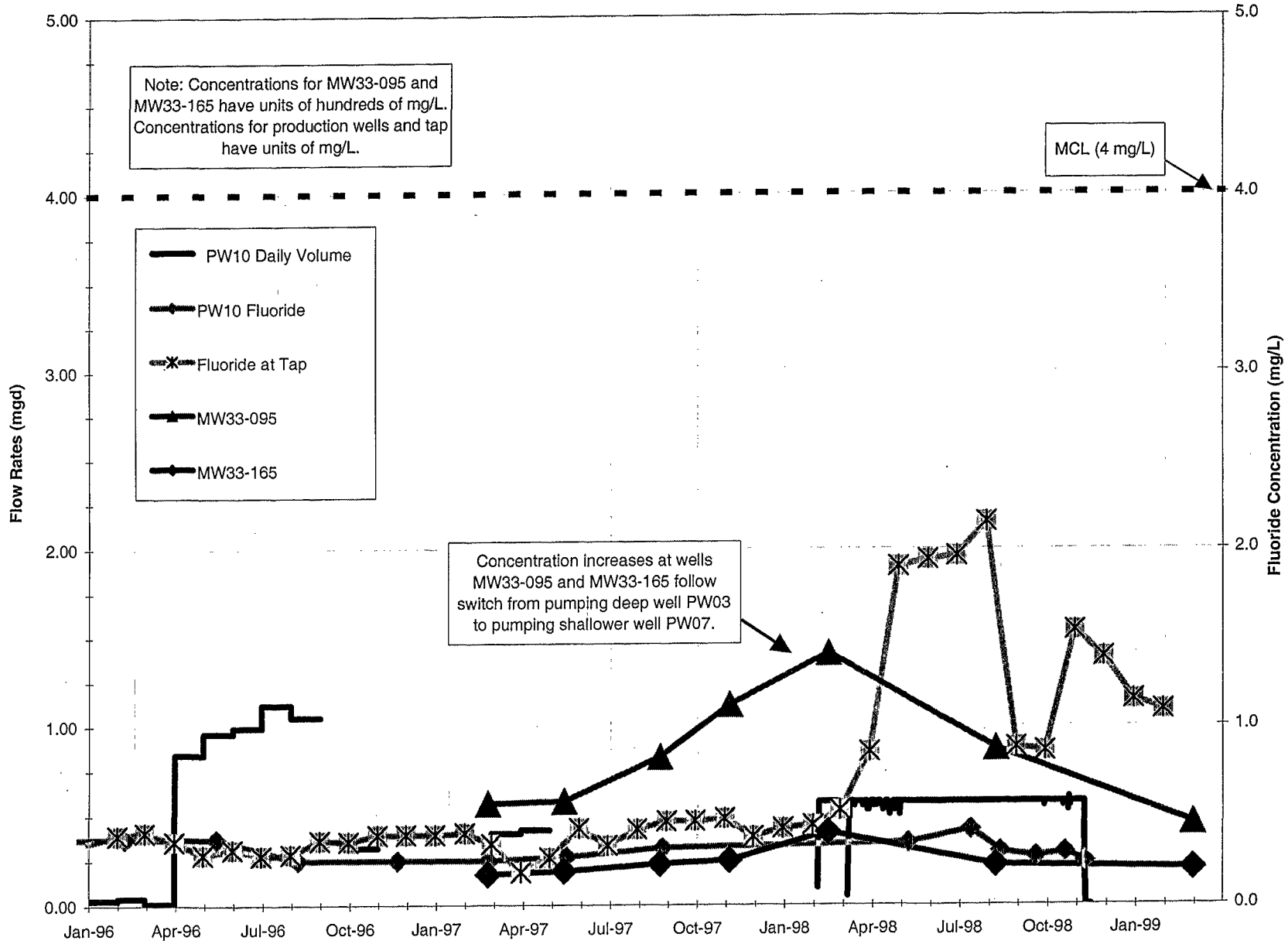

Figure 5-17
Production Well Pumping Rates and Fluoride Concentrations at PW10 (January 1996 - March 1999)
Reynolds Metals Company - Troutdale, Oregon
Groundwater Remedial Investigation Report

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